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The British Association. THE recent meeting of the British Association at Cardiff was not especially rich in electrical papers, although they contained much of general interest. We give elsewhere in these columns a sketch of the proceedings of the mathematical and physical section written by Dr. Oliver Lodge. It is unfortunate that the electrical work of the association is somewhat scattered, as a portion of it turns up in the engineering section, while the theoretical papers are part of the work of section A just mentioned. Several researches on the propagation of Hertz waves along wires were read, and while of quite a little theoretical interest, showed only too plainly that we have much yet to learn concerning the electrical radiations which, when their discovery was first announced by Prof. Hertz, seemed beautifully simple and satisfying. When it comes to experimental investigation, however, the subject is one that involves desperate difficulties, the more because of our inability to command by any apparatus now available anything in these long waves corresponding to monochromatic light. Aside from this extremely theoretical work some considerable advances in the theory of electrolysis were reported, and an interesting paper was read dealing with the passage of electricity from points, more especially with reference to the mechanism of electrical discharge through gases. The author, Mr. Chattock, showed some singular analogies between the discharge of vacuum tubes and electrolytic conduction in liquids. Perhaps, however, the most important work of the section was the discussion of electrical units, a topic always interesting and never exhausted. Although no definite suggestions were brought forward the subject was ventilated in a way that at the next electrical congress will undoubtedly be productive of results. Altogether this last meeting of the British Association, although not as productive as some of the former ones, brought forward a considerable amount of interesting matter, much of which will bear considerable study. Some of the practical papers presented we reproduce elsewhere.

Scientific Societies and Publications. THE résumé of the proceedings of the British Association for the Advancement of Science, given elsewhere in our columns, is, from an educational point of view, very interesting. The meeting was anything but rich in purely electrical work, and yet what a contrast to the almost total absence of similar papers in the American association that fills the corresponding place. To be sure the American Institute of Electrical Engineers, together with the various electrical journals, takes excellent care of the really electro-technical work, but the purely scientific investigations seem to have no well recognized organ, with the unfortunate result that the literature of the subject is sadly scattered. The Institute might profitably encourage the presentation of occasional abstract researches and we of the journals can well lend an occasional hand, but the amount that can thus be done is limited and needs to be supplemented. If the American Association for the Advancement of Science does not feel equal to the task, one of our great institutions of learning might well gather about itself by a little encouragement a considerable proportion of the abstruse researches in electricity and other branches of physics. The London *Philosophical Magazine* is an eminent example of selected investigations, and it is a pity to see really good American work driven across the water for publication, in want of a proper outlet here.

Electricity in the Census. THE action taken by the superintendent of the census in suspending special reports has naturally been the subject of much adverse criticism, and if any particular text for disapprobation were needed we have it resting on our table in the shape of the electrical census schedules arranged by Mr. Foote, the special agent for the department of electrical industry. The various blanks sent out make a considerable volume and they give in the most complete and exhaustive manner the details of the electrical arts and sciences. The suspension of so careful an investigation is a serious misfortune, for its continuance and completion would more than anything else succeed in giving a definite form and system to the electrical business that in the beginning was particularly erratic in method and only recently has begun settling down to a sound basis. This eleventh census of the United States has not been a shining example of good management in any particular—about its only redeeming feature has been that it included the work of a considerable number of expert special agents on the industries of our country; as an enumeration of inhabitants merely, it is likely to receive in the future very little respect, and if through the reckless use of funds in other directions the superintendent of the census is without means to carry on that portion of his general work which is likely to prove of value there will be very little to be proud of left in the present census.

Electrical Heating. AN article elsewhere in our columns gives some interesting facts regarding modern electrical heating apparatus. This development of applied electricity in anything like a practical form is a very recent one, and is worthy of thoughtful investigation. There are, perhaps, comparatively few cases where, in absolute matter of expense, electricity can compete with even our present very unscientific stoves, but the question of convenience has a very real commercial value; in other words, a man is willing to pay a reasonable extra price for anything that tends to his personal comfort. The hopeful feature of electrical heating depends largely on this fact. Already, for the purpose of heating cars, electricity is coming into a fair amount of use, and for this very reason. The stove as applied in most street cars is a nuisance, nearly roasting a few passengers in order to make the remainder tolerably comfortable. If ever half the cars of a given road were heated by electricity and the others by stoves, experience would very probably show that the electrically heated cars would get a good deal more than half the traffic, besides having a slightly greater capacity. For other purposes than such special applications the use of electrical heating has less of economy probably than some of its advocates would claim, but still is worth thinking about and giving a fair trial. At all events, the subject is an interesting one in which practical developments may be expected.

Education of the Electrical Engineer. AT the recent electrical congress in Frankfort the topic that forms the title of this note was the subject of a lively discussion. As usual the professor of abstract science and the practitioner of everyday engineering took rather opposite views of the question. The sense of the meeting was strongly in favor of a practical engineering education, perhaps not so exclusively mechanical as that indicated in the famous dictum of Sir William Thomson that the electrical engineer should be nine-tenths mechanical engineer, but with a tendency in the same direction. Dr. Werner von Siemens made several suggestions during the course of the discussion that are worth thinking about. For one he suggested what has been frequently felt by others that the difficulty with the scientific man was that he inclined to think the work required in practice beneath him; the other suggestion especially valuable was that men studying various branches other than engineering and applied sciences other than electricity ought to have in these days a very fair working knowledge of applied electrics. Mechanical engineers, chemists, architects, and the like, would find a moderate working knowledge of electricity very valuable to their respective arts. Both these bits of advice we commend to educators. The first, that they may strive to produce what is really the highest type of electrical engineer, he who is at heart a thorough scientist, but is willing and ready to take off his coat and go to work alongside the constructing mechanic if necessary; and, second, that they may give electricity a place in the courses in which it now generally forms a very unimportant part. It is well to realize, too, that while the electrical engineer must also be a mechanical engineer, in ordinary institutions through the finite amount of time at the students' disposal a compromise may frequently be found to result in too little electricity. Sir William Thomson's suggestion if taken literally is more honored in the breach than in the observance, and we are glad to note that there is beginning to be a somewhat reactionary tendency in the direction of better planned electrical courses. In one recently instituted at the University of Wisconsin, at the head of which is a thorough practical engineer, there is included more electricity and less mechanics than are usually found in our smaller institutions, and on the whole this may be regarded as a good move. He who enters into the active work of modern electrical science must first know electricity, the more practically the better, and if electrical training be sacrificed to something else it is likely to produce a man who is neither a good electrician nor a good mechanical engineer.

Some Peculiarities in Dynamos. THE chief theoretical difficulty in dynamo construction, the point at which theory most generally fails to take account of actual conditions, centres about the air gap, and the magnetic disturbances that occur therein. Prof. Ryan's paper read before the American Institute of Electrical Engineers, is a careful and praiseworthy attempt to investigate some of the phenomena that occur at this point, It is based on a considerable series of experiments, and hence is a valuable source of facts as well as an adjunct to the proper working out of the theory of the subject. Especially were his experiments interesting as showing in a striking manner both the large differences in performance that may be traced to comparatively small changes in the magnetic circuit in and about the air gap; and also as illustrating the bearing of this fact on the theory of compound winding. Perhaps the one point most carefully investigated was the effect of saturation at the corners of the pole pieces and the consequent introduction into the magnetic circuit of a resistance disturbing not only the induction through the armature, but the distribution of the field at the points where its effect on sparking is most noticeable. In all this of course the so-called armature reaction is involved in a complicated manner, and, by the way, it is a fact not as well known as it should be that this particular source of difficulties in dynamo designing is to a very large extent eliminated where by the employment of teeth or winding under the surface of the armature the magnetic resistance of the air gap is very much reduced. Under such conditions, if, as can be readily done by a little care in shaping the tips of the pole pieces to avoid sparking, it becomes possible to run the armature at little or no lead, the magnetizing effect of the armature turns can be almost or quite neglected in the design. When the air gap possesses a high reluctance, and especially if the pole pieces are too thin, there is trouble even when the brushes have no lead. Perhaps a considerable number of cases in which the theory as ordinarily taken fails to give the proper amount of compound winding to produce constant potential may be due to the very saturation of the tips of the pole pieces that Prof. Ryan has so carefully investigated, but in addition there is a point involved which deserves special study, that is the effect of the armature magnetization on the distribution and effective length of the lines of force in the air gap itself. This may result from a real skewing of the lines of force so as to increase the virtual width of the air gap or in marked variations in permeability under the pole pieces, or in both. However this may be it is certainly the fact that in many machines as the air gap increases the armature does produce a certain added amount of reluctance, even when there is no lead of the brushes, and hence no direct counter magnetizing force. All this is worth careful and thorough research, for modern dynamo designing has reached a point where it is highly desirable that theory should take cognizance of all disturbing conditions, even when they are limited to special cases such as may result from lack of care in arranging the air gap or from demands upon the machines that may absolutely require a large air gap, such as may be found for example in small dynamos and motors for high electromotive force.

Latest Foreign Electrical News.

(By cable from our Own Correspondent.)

London, Sept. 28, 1891.—A deputation from the Glasgow municipality, which has been for a long time perturbed concerning things electrical, has visited Frankfort-on-the Main to get information as to electric lighting and traction.

Mr. C. E. L. Brown has severed his connection with the Oerlikon company, of which he was for some years so important a part.

It is proposed now to transmit all the power required for the great electrical exhibition at the Crystal Palace from some distant point. The experiments at Frankfort have apparently stirred up the authorities of that exhibition to attempt something special in the way of long distance transmission.

Some interesting naval manœuvres have been carried on recently, particularly with reference to coast defense, and several night attacks have been made, testing among other things the capabilities of the projectiles with which the forts on the Thames are equipped. The value of the search-light in defensive warfare has, except for the few instances in the recent war in Chili, been but little subjected to practical tests, hence these manœuvres, which are of considerable military and scientific value.

The Frankfort Electrical Congress.

BY CARL HERING.

The opening session of the congress was mentioned in the last letter. The programme was carried out about as published beforehand; the general meetings of the whole congress, and the separate meetings of the five different sections, were devoted entirely to the reading of papers, except in the fifth section, which had for its object the establishment of laws and rules to prevent interference in cities between strong currents (for electric light and power) and weak currents (for telegraphy and telephony).

Among the papers read in the various sections were a few very good ones, some were indifferent, or some even poor. It was a great mistake to have all the papers read in full; some might to advantage have been read by title and others omitted entirely, as out of place at an international congress. When electricians assemble from all countries to listen to papers, such papers should be limited to matters worthy of their time and attention. On similar occasions in the future it would be well to have the papers approved by a committee before they are put on the programme.

In one sense this congress was truly international, as papers were read and discussed in German, English and French, and judging from the attention and applause, the foreign languages, French and English, were generally understood. It is to be regretted, however, that such a good opportunity was lost to at least discuss, if not settle, some matters of international importance to electricians. As it is, this congress was only an international meeting of electricians, for reading and discussing papers. An attempt was made on the part of the delegates of the American Institute of Electrical Engineers, and of Mr. Hospitalier, of Paris, to bring up for discussion, and if possible for settlement, some important matters, but notwithstanding that everything possible was done by the above nothing was accomplished by the congress. The chief reason was, perhaps, that the time was too short (or perhaps that there were too many special papers) to discuss questions of international importance. It was claimed that such matters should have been announced months in advance, so as to give plenty of time for preparing a discussion. This is true in some respects, and it will be well for the promoters of the next international congress to take a lesson, but on the other hand it is no more than right to say that the questions brought up by the delegates of the American Institute of Electrical Engineers were all suggested, informally, by the writer in a personal letter to the promoters of the congress as early as the beginning of this year, of which latter suggestion, however, no notice appears to have been taken. A week before the meeting the delegates asked what action should be taken to give due notice that they would bring up these matters. As no notice was taken of this request the delegates of the American Institute of Electrical Engineers prepared a short notice, and through the kindness of the directors had it printed in the official programme the day before it was to be discussed. Notwithstanding this the matter was not even read, but was referred to a special committee to report at the next general session. It cannot be claimed, therefore, that there was not sufficient effort made to bring up the matters.

Mr. Hospitalier's very good suggestions in his paper on "Conventions et Symboles de l'Electrotechnique" (conventional signs and symbols employed in electrotechnics), read in French at the second general session, met the same fate, being referred to this same committee. In this interesting paper he spoke of the great variety of symbols and letters used, and the great want of uniformity, and suggested to adopt a uniform and systematic set of symbols, which are to be the same in all languages. He was furthermore prepared to offer such a system, which he had formulated. His suggestion to adopt some such system did not fail to meet with hearty approval, though, as might be supposed, it will be very difficult to determine upon one set which would meet with universal approval. Some radical change in our present self-made systems must evidently be made, and the sooner it is done the better.

The committee to consider these subjects was appointed by the chair, Mr. Werner Siemens, and consisted of the following gentlemen, those who did not attend the meeting being omitted here: Braum, Grawinkel, Loewenhertz, Kohlrausch, Strecker, Uppenborn, of Germany; Ryerton, Preece, Thompson (Sylvanus), of England: Ferraris (chairman), Roiti, of Italy; Hering (secretary), Nicholls, of United States; Hospitalier of France; Weber, of Switzerland. With this committee something would no doubt have been accomplished had there been time, but the programme for the members of the congress provided for almost every hour, so that it was not possible to find sufficient time to discuss the matters properly. There were but two meetings of scarcely an hour each, and in addition to this there was no one language common to all the committee, so that much time was lost in interpreting.

Mr. Hospitalier's propositions were discussed, but it was soon found that the time was altogether too short to arrive at any conclusions regarding a complete system, but the following general proposition was adopted: That all units hereafter are to be expressed in Roman type, all physical quantities in italics, and all physical constants and angles in Greek type. It was also proposed to express the following quantities, viz.: Ampère, coulomb, farad, joule, ohm, volt, and watt, by their initial letters, namely: *A*, *C*, *F*, *J*, *O*, *V*, and *W*, respectively, but this motion was not carried, notwithstanding that it was reported as carried to the subsequent general session of the congress and there approved; being approved there, it represents the expression of this congress, although it was based on a misunderstanding of the conclusions of the special committee. The committee furthermore expressed their approval of the suggestion to adopt some uniform system of conventional signs and symbols; they recommend that the subject be discussed publicly in the technical journals, and that the final adoption of such a system be left to the next congress, (1893).

Regarding the adoption of some new units and names, the following is a résumé of what transpired at the committee meeting: The action of the last congress (Paris, 1889) regarding units was approved. The suggestions of the delegates of the American Institute of Electrical Engineers were then considered. They were, in brief, to adopt the name "henry" for the unit of self induction, whose value has already been adopted as that of an earth's quadrant; to adopt the name "gauss" for a unit of magnetic intensity, and to make it equal to 1,000 absolute units; to establish some standard value for the resistance of copper. As there was a decided difference of opinion as to whether the unit of magnetism should represent the *intensity* or *density*, that is the *number of lines* (or absolute units) *per square centimetre*, or whether it should represent a *quantity* of magnetism, or *number of lines of force*. Mr. Hering amended the proposition by suggesting that to avoid a misunderstanding *both* of these practical magnetic units should be adopted and named, and that for the latter he suggested the name "weber." The intensity or density of a field of a dynamo for instance, that is the number of lines per square centimetre, would be expressed in *gausses* and the total field in *webers*. The relation of gausses to webers would be expressed by the following formula:

Webers = gausses × cross section of field in square centimeters.

Their dimensions in the absolute system would be

$$\text{gauss} = L^{-\frac{1}{2}} M^{\frac{1}{2}} T^{-1}.$$
$$\text{weber} = L^{-\frac{3}{2}} M^{\frac{1}{2}} T^{-1}.$$

Furthermore, that the relation between a gauss and a weber be unity, in which case, a weber would be equal to 1,000 absolute units.* This is the form in which the proposition was originally made to the committee by the Americans. Prof. Sylvanus Thompson suggested that in order to preserve the uniformity of the present system, the value of the practical units should be made 10^8 absolute units. In that case a conductor moving through a field of *one* practical unit, in *one* second, will generate *one* volt. This suggestion appears to be a good one and seemed to meet with general approval. The real practical unit of intensity would then be the microgauss instead of the gauss, and a field of say 15,000 lines per square centimetre would be represented by 150 microgausses, as the microgausses would then be equal to 100 absolute units. A question arose, what the relation between a weber and a gauss should be in order to preserve the unity of the system. Although the suggestions regarding the magnetic units met with general approval, the time of the committee was unfortunately so limited that it was concluded to take no definite action here, but to recommend that the matter be acted upon at the next international congress.

Regarding the name "henry" there was some adverse criticism, but only from the German members. It is probable that all the other members would have been willing to formally adopt this name; Mr. Preece, of London, stated that the Royal Society wished him to express their approval of the adoption of this name. The German members (to most of whom the name *henry* was an entirely new matter) objected, however, some claiming that Henry had not made any important researches, that Neumann ought to have the credit, that if it must be an American name it ought to be Franklin, that it would conflict with the name "quadrant," etc., all of which objections were duly answered. As it was evident that no unanimous conclusions could be reached, the proposition regarding the name henry was withdrawn.

As the limited time of the committee had expired, the matter of the standard value for the resistance of copper did not come up for discussion at all.

At the general session of the congress following this committee meeting, the report of the committee was read and their recommendations, as given above, were adopted.

It will be seen therefore that practically no international business was accomplished by this congress, which is to be regretted very much. As these matters were formally left to the next congress it is to be hoped that the two years between this and the next congress, which is to be held in Chicago in 1893, will be made good use of to practically settle such questions, leaving only their formal adoption to that congress. A congress is hardly the place to discuss such questions; the discussions ought to precede the congress, leaving to it only the final formal adoption. Under the circumstances it would be well for the American Institute of Electrical Engineers to take a leading part, and, together with other leading national societies of the different countries, arrive at some definite conclusions to bring before the next congress for adoption.

Frankfort A. M., Sept. 12, 1891.

* As the field intensity of a dynamo is usually some thousand absolute units it would be expressed in gausses directly, without recourse to any prefixes. The total field is usually some million absolute units, and would therefore be expressed in so and so many thousand webers.

Electrolytic Separation of Zinc.

The process introduced by M. Nhansen may be applied to the electrolytic separation of zinc by employing a bath, the temperature of which can be lowered according to the density of current employed. The inventor notices that the temperature must be lowered as the density of current is reduced. The mean of 120 observations is shown in the following table:

Density in ampères.	State of metal obtained.			
	10 deg.	20 deg.	30 deg.	40 deg. Cent.
10	compact	spongy	spongy	spongy
50	.....	semi-comp.	. . ....	.....
100	....	compact	semi-comp.	. ....
150	....	.....	compact	semi-comp.
200	.... ..	.....	.....	compact

If it is desired to work with a density of "100 per square metre," the bath, to obtain compact metal, must be kept about 20 degrees C.

A Point of Economy in the Working of Electric Light and Power Stations.

BY LEONARD PAGET, PH. D.

I am in receipt of an article from the *American Wool Reporter* of July 30, which is partly an unsigned criticism (or mild counter-blast) to my article, entitled as above, that appeared in The Electrical World of July 25 last. The critic admits that he fails to "see the point," although he says "we have carefully read this article," and of course having failed to see the point immediately sets out to refute it—by his opinion and sarcastically. Now sarcasm is very like a buzz saw; it's a cutting thing in proper hands, but a queer thing to fool with. He fights the statement that a considerable quantity of the fuel used, amounting to as much as a quarter, is used to create a draught in the chimney; and he denies that we can produce the same draught in a more economical way with less expenditure of fuel; and unfortunately he prophecies as follows: "We predict that his remedies will cause a loss of even more than 25 per cent. in what he claims is due to the creation of a draught." Putting the worst construction on this somewhat vague sentence (although vagueness is quite in order since it is a prediction), we are, therefore, to understand from this unknown authority (unknown, of course, because unsigned) that an artificial blast will produce waste of fuel. But on this point I will quote a known authority, the highest and best known I *could* quote—Prof. Rankine.

In the eleventh edition of his classical work on the steam engine (p. 272) Prof. Rankine shows that with a chimney the best possible draught should be produced by a temperature in that chimney of 600 degrees Fahr. above the temperature of the external air, and then, continuing in his own words, "it appears that under no circumstances can it be necessary to expend more than one-fourth of the total heat of combustion for the purpose of producing a draught by means of a chimney." Now one-fourth of the total heat of combustion means a great deal more than one-fourth of the fuel, because it does not include the unburnt fuel nor the fuel escaping as combustible gases. But to continue, Prof. Rankine says: "When the draught is produced by means of a blast pipe or of a blowing machine, no elevation of temperature above that of the external air is *necessary;* and with a forced draught less air is required for dilution, consequently a higher temperature of the fire, consequently a more rapid conduction of heat through the heating surface, consequently *a better economy of heat than there is with a chimney draught.*" I am awfully sorry for the critic, but really I must follow my professor.

The next point the critic does not see is that the introduction of steam does not give better conduction than the existence of a merely gaseous atmosphere in the furnace, and he says, "The doctor of physics, who is the author of this article, has probably forgotten that steam introduced into a furnace cannot retain its aqueous condition, but immediately assumes a superheated state, which is practically dry gas." My critic ought to know that Ph. D. doesn't mean "doctor of physics." And will he define what he means by "dry

gas?" Superheated steam, however much you superheat it even to decomposition, is still H_2O, and that is aqueous vapor, plus so much heat which is thus absorbed to be given out again to the body and flues of the boiler, whence results the conductivity.

Then my critic falls foul of me thus: "A third 'point of economy,' we find, is that if the grate of a boiler is too small and it cannot be enlarged, air must be introduced above the fuel on account of the imperfect combustion which attends the use of too small a grate" (now this is really honest). "We hardly know what he means by this, but we would be glad to have him go into some cotton or woolen mill where they are pressed for steam, and let him try to increase the production by following out this idea."

My critic admits readily enough that he does not know that it is possible to increase combustion by admitting more air, *except through the grate.* For the sole information of my critic (because every one else knows it), it can be stated that with imperfect combustion on the grate, due to want of air passing through the fuel, there are distilled off from the coal combustible gases which will take fire above the fuel layer, and burn there if air be admitted in proper proportion, whereby the heat of these burning gases is not lost by the gases passing unconsumed into the chimney. If this is still not obvious to him I refer him to Mr. D. Kinnear Clark's researches, now some 20 years old, on this point. I would be very glad to advise the cotton or woolen mill proprietors, and take my charges out of the economy gained, but I fear I shall not find any intelligent proprietor of such a business who has not avoided this evil when he consulted his engineer in the construction of his boiler house.

But where the shoe pinches is shown in the next quotation from this "criticism:"

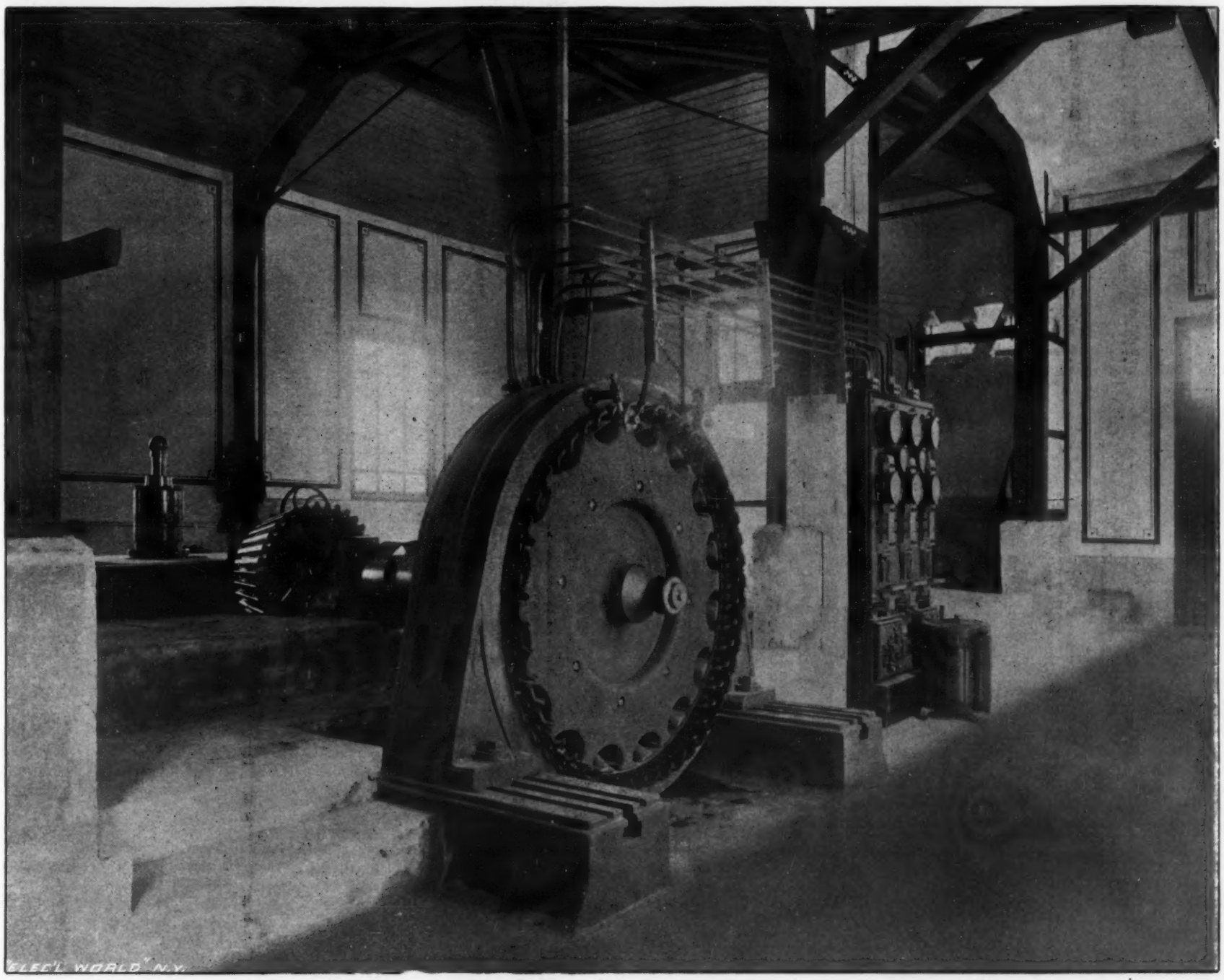
"A fourth 'point of economy.' and the last which he has succeeded in evolving, is that the best practice is to employ a thin fire frequently replenished by careful firing. From the tenor of his remarks it may be concluded that the proper thickness of fire is no more than two inches, and he advises the superintendents of central lighting stations to try this. We have only to say that we should like to see this doctor of physics in a fireman's garb endeavoring to maintain a bed of coal on the grate of a furnance at a uniform thickness of only two inches."

This is a wilful misstatement of the advice given in the article as to the advantage of thin layers of fuel, but then the critic could not be expected to forego the presentation of so sarcastic a view as a "doctor of physics in a fireman's garb" endeavoring to maintain a thin fire. Now a "doctor" (that is, technically, a teacher) of any kind is not worth his salt unless he *knows* what he is writing about. Hence our critic is not a doctor of criticism as regards doctors (especially of physics), and neither of things pertaining to firemen unless he, like the doctor who wrote that poor article, can do better than don a fireman's garb, that is, make his firemen keep a thin, uniform fire.

My critic concludes with the "hope that superintendents of electric light stations will not spend money trying to find these various points of economy, for it will be (he thinks) money thrown away." Whether that will be the case does not appear, except in the opinion of the critic, who advances not a single argument in favor of that opinion, except it be as to the absurdity of a "doctor" knowing how to fire a boiler.

Generating Station of the Lauffen-Frankfort Line at Lauffen.

The accompanying illustration gives a view of the interior of the dynamo room at the Lauffen transmission of power plant. The building is at the Wurtembergische Cement Works at Lauffen, that beautiful branch of the Rhine that winds through Wurtemberg along one of the most beautiful river valleys in the world, finally joining the Rhine at Heidelberg. The motive power of the station is a horizontal turbine, having a speed of 50 revolutions and a capacity of 300 h. p., under a head of about 10 feet of water. The transmission to the dynamo is effected by a pair of large beveled gears; the ratio of the dynamo is about three to one, driving the dynamo very nearly 150 revolutions. The dynamo and the electrical part of the plant have already been described in the columns of THE ELECTRICAL WORLD, so that there is comparatively little to say of the electrical details of the station. We have already noted the success of the plant and are sure that our readers will be interested in a glance at the interior of what is really the pioneer station in the new development of electrical art. For particulars we can do no better than to refer to the previous articles we have published on the subject.



GENERATING STATION OF THE LAUFFEN-FRANKFORT LINE AT LAUFFEN.

Lake Girard Mica Mine.

One of the most striking objects at the Electrical Exhibition which has just closed at Montreal, Que., was an exhibit of mica from the above mine, which is the property of Thomas J. Watters, of Ottawa, Canada. In the exhibit was included some 50 sizes of cut mica ranging from $1\frac{1}{2} \times 2$ up to 10 inches by 13 inches, while there was also shown a section of a rough crystal which measured $3\frac{1}{2}$ feet $\times$ 2 feet. The quality of this mica is of the best, and this mine would appear to be the richest and most productive amber mica mine on this continent. It was discovered in September, 1890, and was opened up by the firm of McVeity, Powell & Skead, who worked it for a period of about four months, during which time the entire output was sold under contract, in rough form, to Mr. F. W. Webster, purchasing agent, representing the Thomson-Houston Company of Lynn, Mass. The deliveries during the four months were about 120 tons, which has all been shipped to the United States market. The mine was shut down in February last, as the water was making in the shaft so rapidly that it could not be overcome with the limited facilities which were then in use on the property, and it remained inactive until the latter part of May last, when it was purchased by the present owner, who has since placed the work on a proper footing and is now steadily operating day and night gangs. The average weekly output is $12\frac{1}{2}$ tons of merchantable rough mica, and the shaft is now down 80 feet, with an average width of 20 feet square, the mica becoming more free from cracks and the size of the deposit increasing as the shaft is lowered. There are now seven pairs of shears in constant work, giving an average weekly output of 1,800 to 2,000 pounds cut mica, according to size. The excellent quality of this mica has been admitted by most of the electric companies of the United States, who have been supplied with it through the Thomson-Houston company or the Crystal Mica Company of Boston, to whom the early product of the mine (rough split) was shipped by Mr. Webster. The present owner of the mine, however, having provided all the necessary facilities to enable him to supply the cut and finished article to users in this country, is now in a position to accept orders for any desired quantity and size.

There has been much activity displayed in Canada during the past season in the direction of searching for amber mica deposits, and while a number of promising "shows" have been discovered, the fact appears to be that the mine mentioned above is the only one in Canada which is in a position to accept any large orders for cut mica and to guarantee that the same will be filled to the entire satisfaction of the buyer, both as to the quality of the materia to be supplied and the prompt method of delivering

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1775.——Bolten (Joach. Fred.)—*Continued.*

Magnetical cures by different processes are treated of more particularly by Godenius R., Jr., "Tract. de Mag. Curatione . . . ," Marp., 1609; J. Robertus, "Curationis Magneticæ . . . ," Luxemb., 1621, Coloniæ, 1622; Charlton, "A Ternary of Paradoxes . . . ," London, 1650; G. Mascuelli, "De Medicina Magnetica," Franckfort, 1613, translated by W. Maxwell (Maxvellus), 1679–1687; Tentzelius, "Medicina Diostatica . . . ," 1653; A. Van Leuwenhoeck (*Phil. Trans.*, vol. XIX., for 1695–1697, p. 512); J. U. Tetens, "Schreiben . . . Magnet-curen," Bûtzow and Wismar, 1775; Jacques de Harsu, "Recueil des Effets . . . ," Geneva, 1783; W. Pigram, "Successful Application . . . " (*Phil. Mag.*, vol. XXXII., p. 154); Kloerich, F. W., "Versuche . . . " ("Götting. Anzeigen," 1765), "Von dem Medicin . . . " Göttingen, 1766; M. Mouzin, "De l'emploi . . . Maladies," Paris, 1843. See, likewise, A. D. 450.

A. D. 1775.——Volta (Alessandro), an Italian natural philosopher and professor at the University of Pavia, who had already, in 1769, addressed to Beccaria a Latin dissertation, "De Vi Attractivâ ignis electrici, etc.," makes known his invention of the *electrophorus*, a sort of perpetual reservoir of electricity. The latter consists of two circular metallic plates having between them a round disc of resin, which latter is excited by being struck a number of times with either a silk kerchief or pieces of dry warm fur or flannel.

While endeavoring to improve the electrophorus he discovers, in 1782, what he calls an electrical condenser, wherein the disc of resin is replaced by a plate of marble or of varnished wood. With it he is reported (*Philosophical Transactions*, vol. LXXII.) to have ascertained the existence of negative electricity in the vapor of water, as well as in the smoke of burning coals and in the gas produced by a solution of iron in weak sulphuric acid. He also invented the electrical pistol and was the first to improve upon the observations of Galvani. An account of his many experiments appears in letters addressed by him to Prof. Don Bassano Carmenati, of the Pavia Medical University, April 3, 1792, and to Tiberius Cavallo, Sept. 13 and Oct. 25, 1792, as shown in the *Philosophical Transactions* of the Royal Society, which latter institution gave him its gold Copley medal.

Volta's crowning effort, however, lies in the discovery, through Galvani's experiments, of the development of electricity in metallic bodies and in the production of the justly famous pile which bears his name. The latter consisted of an equal number of zinc and copper discs separated by circular plates of cloth, paper or pasteboard soaked in salt water or dilute acid, all being suitably connected to develop a large quantity of electricity.

Thus, says Dr. Dickerson in his address at Princeton College, Volta gave to the world that new manifestation of electricity called Galvanism. In that form this subtle agent is far more manageable than in the form of static electricity; and by the use of galvanic batteries a current of low tension, but of enormously greater power, can be maintained with little difficulty; whereas static electricity is like lightning, and readily leaps and escapes on the surfaces on which it is confined.

"It was Volta who removed our doubtful knowledge. Such knowledge is the early morning light of every advancing science, and is essential to its development; but the man who is engaged in dispelling that which is deceptive in it, and revealing more clearly that which is true, is as useful in his place and as necessary to the general progress of science as he who first broke through the intellectual darkness and opened a path into knowledge before unknown." (Faraday's "Researches.")

The last-named discovery, though made in 1796, was first announced only on the 20th of March, 1800, in a letter written from Como to Sir Joseph Banks, by whom it was communicated to the Royal Society. It was publicly read June 26, 1800. (*Phil. Trans.* for 1800, Part II., page 408.)

Volta, at about the same period, constructed an electrical battery, which has been named *La Couronne de Tasses* (the crown of cups), and which consists of a number of cups arranged in a circle, each cup containing a saline liquid and supporting against its edges a strip of zinc and one of silver. As the upper part of each zinc strip is connected by a wire with a strip of silver in the adjoining cup, the silver strip of the first cup and the zinc strip of the last cup form the poles of the battery. It is said that twenty such combinations decomposed water and that thirty gave a distinct shock.

On the 16th, 18th and 20th of November, 1800 (Brumaire an. IX.), Volta, who had obtained the permission of the Italian government to go to Paris with his colleague the Prof. Brugnatelli, delivered lectures and experimented before the French National Institute (Sue, "Histoire du Galvanisme," vol. II., p. 267). As a member of the latter body, Bonaparte, the First Consul, who had attended the second lecture and witnessed the electro-chemical decomposition of water, proposed that a gold medal be struck to commemorate Volta's discovery, and that a commission be formed to repeat all of Volta's experiments upon a large scale. The commission embraced Laplace, Coulomb, Hallé, Monge, Fourcroy, Vauquelin, Pelletan, Charles, Brisson, Sabathier, Guyton De Morveau and Biot. As chairman, Biot made a report December 11, 1800, which appears in vol. V. of the *Memoires de l'Institut National de France*, as well as in the *Annales de Chimie*, vol. XLI., page 3. In addition to the gold medal, Volta received from Bonaparte the sum of six thousand francs and the cross of the Legion of Honor.

To Volta has been attributed the fact of having, as early as 1777, entertained the idea of an electric telegraph. Fahie quotes a letter of Sir Francis Ronalds, alluding to an autograph manuscript, dated Como, April 15, 1777, and gives its translation by César Cantu, wherein Volta states that he does not doubt the possibility of exploding his electrical pistol at Milan, through wires supported by posts, whenever he discharges a powerful Leyden jar at Como. Nothing more, however, appears to be on record in relation to the matter.

See Arago, "Eloge Historique de Volta" and "Notices Biographiques," tome I., p. 234 ("Raccolta Pratica di Scienze, etc.," for March and April, 1835); London *Times* of January 26, 1860; the eulogies pronounced by Giorn. Fogliani at Como and by G. Zuccala at Bergamo, the year of Volta's death, 1827; P. Sue, "Histoire du Galvanisme," tome II., p. 267; *Journal de Leipsic*, tome XXXIV.; *Scelta d'Opuscoli*, vols. VIII., p. 127; IX., p. 91; X., p. 87; XII., p. 94; XIV., p. 84; XXVIII., p. 43; XXXIV., p. 65; *Opuscoli Scelti*, vols. I., pp. 273, 289; VII., pp. 128, 145; XV., pp. 213, 425; XXI., p. 373; "Mem. dell' I. R. Istit. Reg. L. V.," vol. I., p. 24; "Mem. dell' Istit. Nazion. Ital.," vol. I., p. 125; "Memor. Soc. Ital.," vols. II., pp. 662, 900; V., p. 551; "Bibl. Fisica d'Europa" for 1788; Giornale Fis.-Med.," vols. I., p. 66; II., pp. 122, 146, 241, 287; III., p. 35; IV., p. 192; V., p. 63; "Giornale dell' Ital. Lettera, etc.," vol. VIII., p. 249; L. V. Brugnatelli, "Annali di Chimica, etc.," vols. II., p. 161; III., p. 36; V., p. 132; XI., p. 84; XIII., p. 226; XIV., pp. 3, 40; XVI., pp. 3, 27, 42; XVIII., pp. 3, 7; XIX., p. 38; XXI., pp. 79, 100, 163; XXII., pp. 223–249 (Aless. Volta and Pietro Confligliachi); Aless. Volta and Angelo Bellani, "Sulla formazione, etc.," Milano, 1824; F. A. C. Gren, *Neues Journal der Physik*, vols. III. and IV. for 1796 and 1797; Rozier, *Observ.*, vols. VII., XXII., XXIII., for 1776, 1783; J. B. Van Mons, *Journal de Chimie*, No. 2, pp. 129, 167; Sedillot, "Receuil Per. de la Soc. de Méd. de Paris," IX., pp. 97, 231; *Journal de Phys.*, vols. XXIII., p. 98; XLVIII., p. 336; LI., p. 334; LXIX., p. 343; *Annales de Chimie*, vols. XXX., p. 276; XLIV., p. 396; *Nicholson's Journal*, vol. XV., p. 3; *Phil. Tr.* for 1778, 1782 and 1793; "Soc. Philom.," an. IX., p. 48, an. X., p. 74; "Bibl. Brit.," vol. XIX., p. 274; *Le Correspondant* for August, 1867, page 1059, and *Les Mondes*, December 5, 1867, page 561; Highton, "The Elec. Tel.," 1852, pp. 13 and 28; Robertson, "Mémoires Récréatifs," 1840, vol. I., chap. X. and XIII.; Thompson, "Hist. of Chemistry," vol. II., pages 251–252; "Dict. de Gehler," vols. III., p. 665; VI., pp. 475, 484; Thomas Thomson, "Hist. of the Royal Soc.," London, 1812, p. 451; Young's "Lectures," vol. I., pp. 674, 677, 678, 683.

See, likewise, the "Theory of the Action of the Galvanic Pile," as given by Dr. Wm. Henry at section V., vol. I., of his "Elements of Experimental Chemistry," London, 1823, also *Nicholson's Journal* for Henry's essay in vol. XXXV., p. 259; Mr. DeLuc's papers in vol. XXXII., p. 271, and vol. XXXVI., p. 97; Mr. Singer on the Electric Column in vol. XXXVI., p. 373; Dr. Bostock's essay in Thomson's Annals, vol. III., p. 32; Sir H. Davy's chapter on Electrical Attraction and Repulsion in his Elements of Chem. Philos. p. 125; the first volume of Gay-Lussac and Thénard's "Recherches"; Johann Mayer, "Abhandlungen . . . Galvani, Valli, Carminati u. Volta, etc.," Prague, 1793; *Lehrbuch der Meteor.*, von L. F. Koenitz, Halle, 1832, vol. II., pp. 398, 400, 418; M. Detienne et M. Rouland in *Jour. de Phys.*, vol. VII., for 1776; J. N. Hallé, "Exposition Abrégée, etc." ("Bull. des Sc. d. l. Soc. Philom.," an. X., No. 58); C. B. Désormes' very extended observations recorded in the *An. de Ch.*, vol. 37, p. 284; Volta's letter to Prof. F. A. C. Gren, in 1794, and Wilkinson, "El. of Galv.," vol. 2, pp. 314–325; J. F. Ackerman ("Salz. Mediechirurg," 1792, p. 287); Cadet (*An. de Ch.*, vol. 37, p. 68); letter written by Volta to M. Dolomieu ("Bull. de la Société Philom.," No. 55, p. 48; Friedlander's Experiments (*Jour. de Phys.*, Pluviose, an. IX., p. 101); Paul Erman (*Jour. de Phys.*, Thermidor, an. IX., p. 121; Gilbert's *Annalen*, VIII., X., XI., XIV.); *Jour. de Phys.*, tome LIII., p. 309; *Jour. de Médecine*, Nivose, an. IX., p. 351; P. C. Abilgaard, "Tentamina Electrica"; C. H. Wilkinson, "Elements of Galvanism, etc.," London, 1804, 2 vols., *passim;* A. W. Von Hauch's Memoir read before the Copenhagen Acad. of Sc. (Sue, "Hist. du Galv.," 1802, vol. II., p. 255); J. B. A. Von Scherer's Journal, 31st Book. See, also, account of the immense electrophorus constructed for the Empress of Russia, in vol. I. of "Acta Petropolitana" for 1777, p. 154, etc.

A. D. 1776.——Borda (Jean Charles), French mathematician and astronomer, improves upon the work of Mallet and is the first to establish accurately the knowledge of the third and most important element of terrestrial magnetism, viz., its *intensity.*

To him is due the correct determination of the difference of the intensity at different points of the earth's surface by the measurement of the vibrations of a vertical needle in the magnetic meridian. This he did during his expedition to the Canary Islands, and his observations were first confirmed by others which the companion of the unfortunate La Pérouse, Paul de Lamanon, made during the years 1785 to 1787, and which were by him communicated from Macao to the secretary of the French Academy.

See Borda's biography in the "Eng. Cycl.," and in the Eighth "Britannica;" Walker, "Magnetism," p. 182; De Humboldt on magnetic poles and magnetic intensity, embracing the observations of Admiral de Rossel, and "Cosmos," vol. V., 1859, p. 62, note; Norman (A. D. 1576).

A. D. 1777.——Lichtenberg (Georg Christoph), professor of experimental philosophy at the University of Göttingen, reveals the condition of electrified surfaces by dusting them with powder.

The *figures*, which bear his name, are produced by tracing any desired lines upon a cake of resin with the knob of a Leyden jar and by dusting upon the cake a well triturated mixture of sulphur and of red lead. The latter substances having been brought by friction into opposite electrical conditions, the sulphur is collected upon the positive and the lead upon the negative portions of the cake. Positive electricity produces an appearance resembling feathers and negative electricity an arrangement more like stars.

See Harris, "Frict. Elect.," p. 89; E. Reitlinger, "Sibven Abh. . . . " (Wien Acad.); illustrations in *Sc. Am. Suppl.*, No. 207, p. 3,297; Noad, "Manual," p. 132; Erxleben's Physikalische Bibliotek, § 514; L. F. F. Crell, *Chemische Annalen* for 1786; "Göttingisches Magazin," J i., S ii., pp. 216–220; Lichtenberg's "Math. v. Phys. Schriften, etc.," vol. I., p. 478. See, also, Dr. Young's "Lectures in Nat. Phil.," London, 1807, vol. II., p. 119, for additional references, and p. 426 for Lichtenberg's "Table of Excitation."

A Novel Electric Railway for the World's Fair.

Oct. 7 next, the World's Fair grounds at Chicago will be opened to visitors for the inspection of the progressing work, and for their accommodation there is being constructed an electric railway of a most ingenious and novel character, having a capacity of carrying 30,000 passengers per hour, with the greatest comfort, convenience and safety. The railway department of the Chicago office of the Thomson-Houston Electric Company has closed a contract with the Columbian Movable Sidewalk Company, of Chicago, for the electrical and steam equipment of the movable sidewalk which is now being installed. The mechanical and electrical plans and details have been carefully worked out by Mr. G. K. Wheeler, of the company, and under his supervision the entire plant will be installed.

By the time named above there will have been nearly completed a large number of buildings, and there will be much to attract and interest visitors. The electric railway, however, will be one of the leading novelties and attractions. This railway will differ from ordinary railways, in that the passengers are transported on a movable sidewalk instead of by cars of the ordinary type. The scheme is the invention of the Columbian Movable Sidewalk Company, of Chicago, and the installation is being constructed under its patents.

This sidewalk is located on the improved and unimproved portions of Jackson Park, and is to be constructed on an elevated structure 25 feet high and 900 feet long, in the form of an ellipse and is to consist of 75 cars, each 12 feet long, connected together, making one solid train. There is to be constructed two parallel sidewalks, one running at the rate of two miles an hour, the other at four, both walks moving in the same direction. The passengers can step from the stationary walk to the one which moves at the rate of two miles an hour, and if it is desired to move at a greater speed they can step from this walk to the one running at four miles an hour. The passengers can safely walk upon either of the movable sidewalks while in motion if desired.

The structure will be illuminated at night by a number of Thomson-Houston incandescent lights, and, as the grounds are to be illuminated with arc lights, a satisfactory view can be obtained during the evening as well as during the day.

Three of the 75 cars are to be equipped with two 15-h. p. Thomson-Houston railway motors, each mounted upon trucks with wheels 18 inches in diameter. As the car platform, or sidewalk, is arranged it is perfectly level with the stationary walk, allowing the trolley wire to be placed beneath the surface of the platform, and the current taken therefrom by means of small trolleys attached beneath the car floors.

The operation of this train of cars will be arranged in a novel manner, doing away with the use of motor men, the entire train being controlled and operated by one man. There will be constructed at a central point, at one side of the track, a controlling station, which will contain a main switch, reversing switch, automatic circuit breaker, lightning arrester, ampère meter and rheostats, all arranged so that they can be operated by the attendant from that point who will have the train under perfect control.

The power for the operation of the sidewalk will be furnished by the Thomson-Houston 110-h. p. multipolar compound wound railway generator located in a power house adjacent to the track. And in connection with said generator there will be placed a suitable switchboard, regulating, controlling and indicating devices of the Thomson-Houston company's manufacture.

* Continued from The Electrical World, Sept. 26, 1891.

The Elements of Practical Electricity.*

BY DR. LOUIS BELL.

On this power to decompose chemical compounds and deposit the component parts of them at the electrodes immersed in the liquid are based a very large number of useful applications. The simple experiment you have tried by depositing copper from copper sulphate on one of the immersed electrodes is a type of the electroplating and electrotyping processes, and worked on a very large scale is a method used for the purification of metallic copper. A rather interesting exercise to further illustrate the principle of electroplating and electrotyping may be found in copying a seal or coin by the electrolytic process; it is a very simple matter and well worth trying. The object you have in view is to obtain a perfect metallic reproduction of a seal, for example. For this purpose you must first get a good, sharp impression of the particular seal you desire to copy. This can be conveniently done with sealing wax: but it requires a little knack to obtain a perfect reproduction of the seal, and the following is perhaps the best method of going about it. Hold a card over a gas flame, not too close to it, until it gets thoroughly hot, then take a stick of red sealing wax and hold it against the upper surface of the card, moving it about until a sufficient quantity of the wax is melted upon the card; now place the wax and card upon a table and take a careful impression with your seal, having first breathed upon it, or, still better, rubbed it very slightly with vaseline so it will not stick. A few trials will enable you to get a perfect impression of the seal. You now desire to coat this with copper so as to reproduce the seal with which the impression was made. Prepare a sulphate of copper solution by taking one ounce of copper sulphate and an equal weight of sulphuric acid; dissolve the copper sulphate in half a pint of hot water, then add gradually the sulphuric acid and set the solution aside to cool. Now prepare the sealing wax mold for receiving the deposit of copper. Simply connected to a wire and placed in the copper solution, the passage of the current would produce no deposit, because sealing wax is a very good non-conductor, and whatever copper may be deposited would be upon the wire attached to the mold. The best way of giving the sealing wax mold a conducting surface is the following: moisten the face of the sealing wax very slightly with alcohol, then with a little camel's hair brush put upon its surface a smooth, even coating of powdered

Fig. 9.—Prepared Impression of a Seal.

plumbago, which will stick to it quite freely. Do not allow it to collect in lumps, but form a neat coating, going over the whole surface of the impression of the seal and a little of the surface of the wax outside of the impression. The best plumbago to use for this purpose is that already prepared for the use of electrotypers, but if this cannot be obtained, a very soft lead pencil such as artists use may furnish a substitute; an ordinary lead pencil, particularly if at all hard, will not work at all well as a source of plumbago, inasmuch as the lead of the pencils is always in hard pencils, and almost universally in cheaper grades of pencils, composed only partly of plumbago. Now make a connection between this prepared surface and one of the wires from your battery. For this purpose take a fine copper wire, heat the end of it, and touch it lightly upon the sealing wax close to the edge of the impression at a point where it has already been coated with plumbago; the wire will stick easily enough, and more plumbago should then be brushed over the end of the wire and the surrounding sealing wax. Set up one of your Daniell cells and attach your prepared sealing wax mold to the wire leading from the zinc of the battery; attach to the other battery wire a copper plate a couple of inches square; then put plate and mold into your copper sulphate solution that you have previously made ready, facing each other and an inch or so apart. The mold must be immersed completely, but the copper plate should be only partially immersed at first. After the deposit begins to form it can be lowered into the solution to its fullest extent.

As the current flows through the copper sulphate you can easily see the progress you are making. At first a filmy deposit of copper will appear on some portion of the mold, generally close to the leading wire; gradually it will spread until the face of the mold is completely coated, and then the process will go on freely until the work is finished, which should be when the copper deposit is a thirty-second of an inch thick or thereabouts. You can then take out the mold, remove the copper from it by chipping the sealing wax away, and then can back up the copper deposit with solder, and finally trim it around the edges, when you will have a very accurate reproduction of the seal from which the impression was originally taken. The only difficult part of the experiment is to adjust the amount of current that flows through the copper sulphate solution. If the flow is too great, the copper, instead of being deposited in a tough, coherent film, will appear on the surface as a blackish powder. If the current is too weak the copper deposit will look almost crystalline. In the former case draw the copper plate attached to the wire of your battery further away from the mold, or even partially out of the solution; in the latter case immerse the copper plate more completely and move it closer to the face of the mold. Usually you

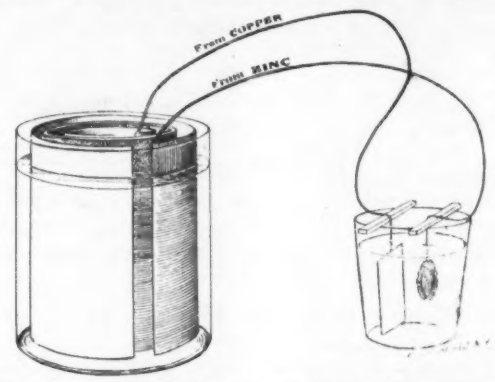


Fig. 10.—Connections for Electro-Deposition.

have no difficulty in getting about the right current strength, when the deposit will be tough, smooth, metallic copper.

A process quite similar to that just described but on a much larger scale is electrotyping. A page of type made ready for printing is used to make a mold, not, however, in sealing wax, but in a cheaper and more convenient material consisting of a mixture of beeswax with a small quantity of turpentine. This mold is then coated with plumbago and coprer deposited upon it much after the method you have employed in copying your seal. The electrotype plate when properly backed up and trimmed is used for printing just as the ordinary type would be. The advantage of the process is that the type is not worn by the actual work of printing and consequently lasts much longer than it otherwise would, while the copper surface of the electrotype being much harder than the type metal, wears but little, even when a very large number of copies are printed.

(To be continued.)

*Continued from The Electrical World, Sept. 26, 1891.

Electrical Practice in Europe as Seen by an American.—VI.

BY CARL HERING.

ACCUMULATORS AT THE FRANKFORT EXHIBITION.

A noticeable feature of this exhibition is the rapid growth of the introduction of accumulators in this country. The Germans have apparently come to the wise conclusion that, like other apparatus and machinery, accumulators are reliable in proportion as they are well made, and that in order to obtain a good article it is necessary to pay sufficient for it that it may be made good, strong and durable. It has been a prevalent opinion among many that an accumulator must be made cheaply and must be very light before it can be generally introduced, and the world has been waiting for such an accumulator. While, of course, this is very desirable, yet there is no reason why we should not make the best of what there is, until we get something better. The present accumulator, if well made and sold

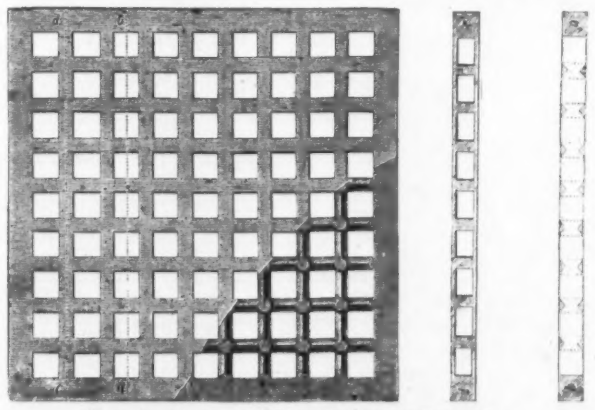


Fig. 1.—Grid of Hagen Accumulator.

for a price which includes a reasonable profit, is a sufficiently good article to be introduced as a very convenient accessory in many cases. This is shown beyond doubt not only by the number of accumulator central station plants in this country, but also by the rapidly increasing demand for accumulators. They are no longer considered as experimental apparatus, which should be avoided as much as possible, but on the contrary their faults and their qualities are well understood, and those faults which cannot be avoided by good construction are simply acknowledged as such and are provided for. Just as the wearing off of the brushes, commutator or bearings of a dynamo are acknowledged to be unavoidable qualities of such constructions and are provided for, so also is the gradual consumption of the material in an accumulator, be it by chemical, physical or mechanical means.

In this country the success of the accumulator for stationary purposes has doubtless been due to the introduction of an accumulator in which weight is of no importance, which is made strong and durable, and in which provision is made for replenishing the material which in all accumulators gradually becomas inactive; in other words, an accumulator of the Planté type, in which such provision is made by slowly increasing the amount of active material at each charge by a very slight overcharge.

The accumulators exhibited here are the following: The "Tudor," exhibited by the Accumulatoren Fabrik Actien Gesellschaft, of Berlin; the "Hagen," exhibited by the Coelner Accumulatoren Werke; the Correns, De Khotinsky, Oerlikon, Pollack and Julien.

Judging from the large number in use, and from the fact that they are used (exclusively, we are told) by the three largest electrical companies in Germany, namely Siemens & Halske, Allgemeine Elektricitäts Gesellschaft and the Schuckert company, it is safe to say that at present the Tudor accumulators give the best satisfaction, and that they give satisfaction is shown by their increased demand. The principle in these is doubtless already well known; we repeat here merely that it is a combination of the Faure and the Planté process. The plates are made of sheet lead rolled so as to form very deep, narrow grooves; a vertical section looks somewhat like two combs with their backs together. The laminæ formed between these grooves, as well as the centre part or backbone, are quite thick. These plates are then formed for one and one-half to two months on the Planté plan, after which the grooves are filled with oxides on the Faure plan; but these mechanically applied oxides form only a portion of the active materials, the main part is formed by the Planté process. By this means they have a sufficiently good capacity at the start, which increases by use, becoming normal after about a year's use. Each charge forms a little more peroxide, which at the same time replaces that which unavoidably detaches itself from the positive plate, and as the plates are originally very thick they last a long time.

For large installations they appear to prefer to use large

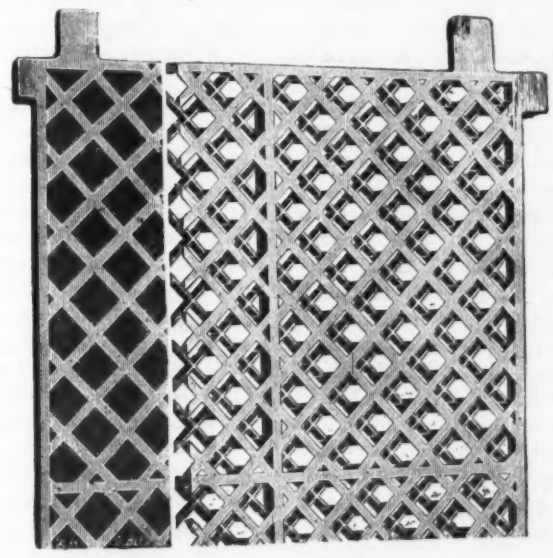


Fig. 2.—Grid of Correns Accumulator.

lead lined wooden boxes in order to be able to place many plates in one retaining cell to avoid placing several cells in multiple arc, which latter would complicate very materially the connections of the end cells, which are not used as much as those in the middle. The like plates are all connected by fusions to one lead bar which is common to two cells; this avoids all contacts by means of binding posts of brass or a lead alloy, both of which are not without objections. All the cells are separately insulated with porcelain insulators containing oil. The plates are quite far apart, so as to avoid short circuits between them. The whole battery is well constructed mechanically and presents a neat and clean appearance.

This system of accumulators has been in use for eight years. At present they claim to have about 1,000 plants in use, among which are the central stations in the following cities: Barmen, Darmstadt, Dessau, Lübeck, Hanover, Breslau, Stettin, Cassel, Mülhausen, Duesseldorf, Koenigsberg, Blankenburg, Altona, Vienna, Trient, Hague, Copenhagen, Stockholm, Sundsvall and Naples. At this exhibition there are several large stationary plants, and a set for a tram car running through the city.

The Hagen accumulators and those of Correns are alike in principle, namely, a grid which is hollow in the inside, so that the paste can form one continuous plate in the inside. The grids of the former are shown in Fig. 1, and consist essentially of two grids held together by little rods. The whole is cast in one piece by the aid of cores of sand, and is therefore a slow process. The Correns grids are shown in Fig. 2, and consist essentially of two grids displaced with reference to each other so that the meshes do not correspond. The two grids are mechanically connected by little cross-rods as in the Hagen. The advantage over the other is that this form can be cast in iron molds. The only difference between these two forms and the usual one is in the construction of the grid, and therefore only some of the objections to the usual form are overcome. The capacity can, of course, be made as great

as one desires, within practical limits, by increasing the ratio of the active to the dead material; but for stationary work, which is by far the greatest field, this is of little importance as compared with other desirable qualities, but which apparently do not exist in these any more than in the usual forms. There have been innumerable forms of grids invented to keep the material from falling out, but as far as we know, not one of them has as yet had any greater success than the simple grid forms. Of both of these makers there are several large stationary plants exhibited here.

The De Khotinsky form differs from the usual grid form in that he allows the active material to expand freely in one direction, and in the other direction the plate is made very narrow; there are therefore not the usual evil effects of this expansion, namely, buckling and loosening of the material. The plates are made as shown by forcing the lead through dies, as in the manufacture of lead pipes. These bands are then cut into lengths and mounted with suitable terminals cast on the ends. In the older forms the plates were placed horizontally, but they are always vertical, even for very shallow troughs.

The accumulators of the Oerlikon Company (Schoop) have also been described before, and they have not been altered lately. As is known, the chief features are: That the current from the positive plates is led off at two corners at the top, and from the negatives at the bottom corners; that they are braced again by a rod passing through holes in the centres of the plates; and that the space between the plates is filled with a white mineral gelatine which acts to keep the material from falling out. It is not possible to obtain definite figures from which deductions can be made, but it is no doubt safe to say that this gelatine must hinder the rapid circulation of the liquid, which is so necessary for rapid discharges, and that therefore these accumulators cannot be used advantageously for rapid discharges, even though they may stand the strain. The method of making this gelatine is a secret, but in general it is made of soluble glass and sulphuric acid; it is liquid at first and can be poured in between the plates, after which it sets in a few hours. There are several batteries exhibited here—a large one for stationary purposes, another for a launch on the river, and a third for a railroad car running out to the suburbs.

The Pollack accumulators have also been described. They consist essentially of a rolled lead plate having numerous rod-like projections all over the two surfaces resembling a coarse, short-haired brush. These surfaces are then pasted with some oxide or salt of lead over which is laid a plate of zinc; they are then immersed in acid, which reduces the oxide to spongy lead. They are then rolled so as to compress this spongy lead and bend over the little rods, which thereby become hooks and hold this material onto the lead plate. They are then mounted as usual and formed as Planté plates. The details of manufacture are a secret; formerly the lead salt used was the chloride, but this was not a success, as it appeared to be impossible to get rid of the chlorine entirely. They now use neither a chlorine nor a nitrate salt. Before formation the plates of spongy lead will stand repeated bending without detaching the material. We are informed that this accumulator is the only one which in France, according to the courts, is not covered by the Faure patents, as it is a Planté process, in which a plate covered with spongy lead is used in place of a solid lead plate.

The Julien accumulators are well known in the States. The exhibitor here modifies them by piercing a small hole through the centre of each little block of the material. By this means he claims to get better results, because the acid can penetrate better and circulate more freely through the material. We believe this was first suggested by Mr. Huber. They also claim that the material can thereby expand freely, but the holes are so small that it is not likely that it can provide for this.

A few general conclusions might be added here besides those given at the beginning of this article. Large cells seem to be preferred to smaller ones in multiple arc. Wooden, lead-lined boxes on porcelain oil insulators are the rule. Connections between cells are massive lead bars burnt onto the plate terminals; there are no binding posts of lead or other metals. The distance between the plates is generally large. Glass tubes are often used between the plates in place of rubber. Cells are made to stand rapid discharges of from five to three hours. Regarding the capacities we will have more to say in a subsequent letter.

Frankfort O. M., Sept. 8, 1891.

Phosphorescence.

M. Henri Becquerel has recently studied the different manifestations of the phosphorescence of materials under the influence of light and heat, and has communicated some observations upon the subject to the Académie des Sciences. The result of M. Becquerel's experiments up to the present time is to place the phenomenon of phosphorescence induced by heat (hitherto considered as distinct from all other phenomena of the kind) once more in the class of known and studied phosphorescence effects. One fact in particular deserves attention in connection with this subject—the conservation to an indefinite time in certain bodies of a portion of the energy which they have absorbed, and which they emit upon being heated. M. Becquerel asks by what mechanism this energy is thus maintained in its potentiality without appreciable loss. He declares himself unable for the present to answer this question; but he looks to future research for information upon the subject, which may have the most important bearing upon the state of knowledge of the mechanism of light radiation and the storing of energy in its highest and most intense forms.

The Measurement of Liquid Resistances.*

BY J. SWINBURNE.

The great difficulties in measuring liquid resistances arise from polarization at the electrodes. Various methods of eliminating the errors arising from polarization, and from variations of surface resistance due to bubbles, have come

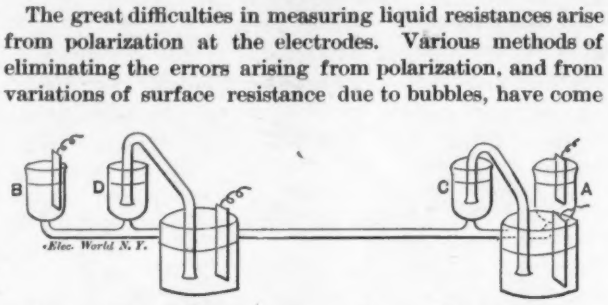


Fig. 1.—The Measurement of Liquid Resistances.

into use; the most usual being to employ an alternating current and a telephone.

The following are some methods of avoiding polarization errors in a manner analogous to that employed by Sir William Thomson, Mr. Heaviside, and others, in measuring low resistances. In measuring low resistances, the resistances of the contacts are high in comparison, and have to be eliminated. Fig. 1 shows the vessel employed. It consists of a glass tube, with cups, *A* and *B*, at the ends, for the main electrodes. Near the ends are feeder cups, *C*, *D*, and it is the difference of potential of these feeder cups that is measured. They are connected by means of parchmented siphon tubes, such as those used in Raoult's cell,

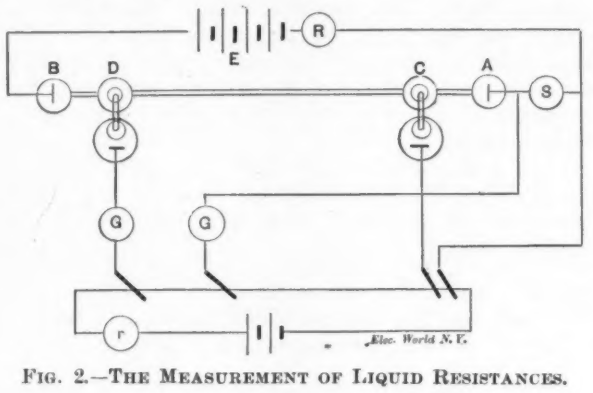


Fig. 2.—The Measurement of Liquid Resistances.

with vessels containing electrodes in a suitable electrolyte. For instance, suppose the resistance of sulphuric acid is to be measured. The main electrodes are platinum or lead. The siphon tubes are filled with acid and connected to vessels filled with sulphate of zinc. The electrodes in these are zinc amalgam. The apparatus may be arranged either so that there is no current from *c* to *d*, or so that there is a current which may polarize the amalgams a little. In this case the polarization can be observed. Fig. 2 shows a method with no current. The main circuit from the battery *E* is through a resistance *R*, which is fairly large, so that variations of resistance or back pressure elsewhere in the circuit do not affect the current much. Then it passes through a standard resistance *S* to the main electrode, then

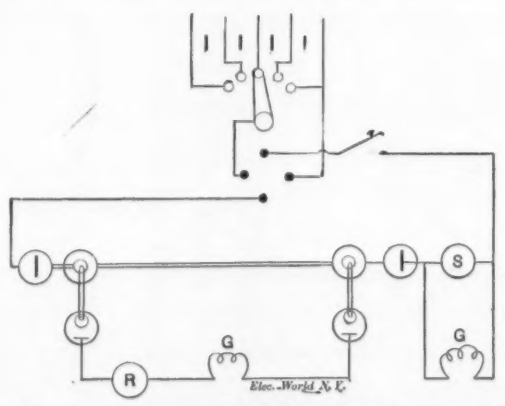


Fig. 3.—The Measurement of Liquid Resistances.

through the tube back to the battery. The fall of pressure between the feeders *c* and *d* is compared with that over the standard resistance *S* by means of the potentiometer arrangement shown diagrammatically. For accurate work a resistance box is used; the wire is only shown for clearness. In this case there is no current in the feeler circuit, and, therefore, no polarization. A deflection can be taken on each side of zero, if desired, so as actually to reverse the current. Polarization of the feeder electrodes can also be detected instantly by breaking both the cell circuits. There should then be no deflection. The drawback to this method is that successive readings have to be taken, and if bubbles are coming off the main electrodes the main current can never be quite constant. Fig. 3 shows another disposition with a differential galvanometer, whose coils are letters *G H*. In this case there is a current in the feeder circuit. To make sure that it produces no error the direction of the main current is commuted quickly at *K*. Any polarization then gives a double deflection. The apparatus may also be coupled up as a Thomson low-resistance bridge. By varying the number of cells, Ohm's law can be checked. As Prof. Stroud has pointed out to me, the resistances of the siphon tubes must be taken into account. They can, however, be made inappreciable in comparison with that of the galvanometer circuits.

Amalgamated zinc does polarize slightly, or some other action takes place which produces an equivalent result. Unless the time of contact is long, however, it does not give rise to trouble. Polarization shows at once by the deflection on lifting the main key.

The main tube is calibrated by filling it with mercury. Mine is straight but it would be better to coil it up to go into a water bath easily. If one siphon tube is not enough a second intermediate tube with a vessel can be used. I think one is generally enough, however. For instance, for measuring caustic sulphate of soda would be used in the siphon tubes, and so on. I have not experimented on various electrodes yet. Amalgams of silver or copper in suitable solutions, or mercury in mercurious nitrate, may be better than zinc amalgam in zinc sulphate.

On the Relation of the Air Gap and the Shape of the Poles to the Performance of Dynamo-Electric Machinery.*

BY HARRIS J. RYAN.

The object of this paper is not to deal with the subject in a new light, but to add to its literature a limited amount of data, the deductions from which go to establish the correctness of the ideas and the utility of the suggestions put forth in the papers read by Messrs. Swinburne and Esson, at the meetings of the Institution of Electrical Engineers on Feb. 13 and 20, 1890. Up to the time of the publication of these papers, the air gap was usually treated by contributors to electrical literature as an evil in a dynamo, having a necessary existence, and the smaller that it could conveniently be made the better. The shape of the poles had often been spoken of as having a somewhat decided effect on the performance of the dynamo, while but little had been said regarding the cause of such an effect.

There exists some difference of opinion as to what should be known as the number of ampère turns on an armature. For our present purpose we will assume that the

$$\text{Armature ampère turns} = \frac{\left\{\begin{array}{l}\text{The number of conductors on the surface of the armature}\end{array}\right\} \times \left\{\begin{array}{l}\text{Strength of current in the armature conductors}\end{array}\right\}}{\text{Number of poles.}}$$

Referring to Fig. 1, it is evident that when we consider the magnetic forces acting in a working dynamo by the route *O, I, J, O*, that the entire number of ampère turns on the armature are directly opposed in action to the ampère turns on the field. By the route *O, M, N, O*, all the ampère turns on the armature except those that lie between the double angle of lead *G, E*, are acting with the field ampère turns, while those between *G, E*, are opposed to the same. Therefore, by this route, the total number of ampère turns actually aiding the field ampère turns is the total number of armature ampère turns, minus twice the number of ampère turns that lie between the double angle of lead. By the route *O, K, L, O*, the number of ampère turns acting is the number of ampère turns on the field, minus the number of ampère turns that lie between the double angle of lead. We can then estimate with ample practical accuracy the magnetic density in the air gap at all points, for any given total amount of magnetization through the armature. The ampère turns that lie between the double angle of lead are opposed to the action of the field ampère turns at all points. It is evident that the portion of the armature ampère turns not included between the double angle of lead will increase the magnetization through the air gap by the route *O, M, N, O*, just as much as they diminish it along the route *O, I, J, O*, as long as magnetic saturation does not take place in the strengthened pole corners *C, D*. If the pole corners are thin, as in the types shown in Figs. 2, 3 and 5, saturation is apt to occur. It is then that the magnetic resistance increases by the route *O, M, N, O*, and the magnetic density by this route is no longer increased by the same amount that it is diminished along the route *O, I, J, O*. On the other hand, when the pole corners are fashioned as seen in Figs. 4 and 6, so that saturation in the strengthened pole corners cannot occur in practice, the current in the armature can produce no modification of the total amount of magnetization through it, other than that which is produced by the action of the ampère turns that lie between the double angle of lead. This action can always be compensated for by putting an equivalent number of series ampère turns on the field acting with the field ampère turns. The double angle of lead can be determined with sufficient accuracy, for with pole corners slightly extended at the centre, see Fig. 11, the diameter of commutation at all loads is very near the weakened pole corners. The pole corners are slightly extended at the centre, so that the coils always

* Paper read before the British Association, in Section A, at Cardiff, August, 1891.

* A paper read before the American Institute of Electrical Engineers.

enter the field of the weakened pole corners gradually. The E. M. F. developed in the coils as they pass under the poles can never be far different from that actually needed to reverse the current in the coil when passing under the brush. In this way the point of commutation in a dynamo can be kept the same when carbon brushes are used without undue sparking, as long as the armature does not reverse the magnetization under the weakened pole corners.

From the discussion of the magnetic relations of an armature to its field in a dynamo in connection with Fig. 1, it is seen that the magnetization in the air gap under the weakened pole corners becomes zero when the armature ampère turns are equal to the ampère turns on the field whose magnetizing force is impressed between its pole faces through the armature. This impressed magnetizing force is that due to the difference between the total number of ampère turns on the field and the number of ampère turns required to set up the magnetization through the field cores, from pole face to pole face. In order to commutate the current without spark at the commutator, the

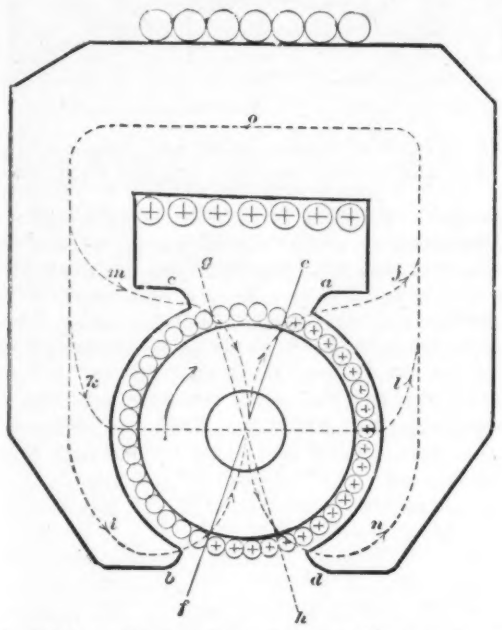


Fig. 1.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

magnetization in the air gap under the weakened pole corners dare never be allowed to become zero. It follows then that the field ampère turns impressing a magnetizing force between the pole faces must always be somewhat in excess of the maximum number of ampère turns on the armature. The amount of this excess need only be sufficient to insure a positive field at *a* and *b*, Fig. 1, strong enough to reverse the current in the coils as they are commutated. When a certain amount of magnetization is to be set up through an armature with the application of the magnetizing force of a given number of ampère turns impressed between the pole faces, we must provide the requisite amount of magnetic resistance between these pole faces. The value of this resistance will have to be such that the impressed field magnetizing force will establish the desired amount of magnetization. This resistance in most cases is best provided for in a proper length of air gap. In general it is found best to avoid heating in the armature core as far as consistent, by the use of comparatively low magnetic densities for wrought iron. The magnetic resistance of the armature core under these circumstances is very small and may be neglected.

The magnetic resistance between the pole faces is occa-

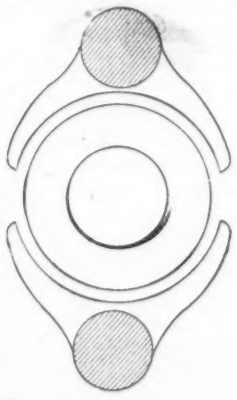


Fig. 2.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

sionally provided for largely either through a saturated core of a ring armature, saturated lugs on armatures where the wires are placed in grooves, or both. This in addition to what air gap may be necessary from a mechanical point of view, go to make up the total amount of magnetic resistance that is provided between the pole faces. Machines of this order have been developed largely through the old and rather expensive method of experimentation. This method has given us some types in which ordinary results are arrived at, through rather extraordinary means. Take the case of a machine with a ring armature, wires wound in grooves, a very small air gap, and poles shaped somewhat as shown in Fig. 2. Such a machine operated as a dynamo may require only a quarter of the number of ampère turns that it will have on the armature at full load for field excitation in order to produce a certain E. M. F. at a given speed. Yet this machine produces a fairly constant potential at the brushes under all variation of load and without undue sparking at the commutator in the following manner: For the production of a constant E. M. F. at constant speed, the total magnetization through the armature must remain constant. At no load one-fourth of the ampère turns needed on the field at full load are provided by a shunt winding. This shunt winding is sufficient to set up the total amount of magnetization for the production of the normal E. M. F. of the machine when there is no current in the armature. Now, in order to take the normal current from the armature without reversing the magnetization under the weakened pole corners, three times as many series ampère turns as there are shunt ampère turns must be added to the field. The addition of these series ampère turns must not increase the total amount of magnetization through the armature, which is accomplished by the thin pole corners. The strong pole corners become saturated when the armature is furnishing even a small amount of the normal current for which it is designed. For most values of the current then, the armature ampère turns tend to diminish the magnetization under the weakened pole corners, but cannot increase it correspondingly under the saturated pole corners. The action of the series ampère turns on the field prevents the reduction of the magnetization under the weakened pole corners to zero, while the saturated portion of the pole pieces prevents the increase of the total magnetization through the armature, and thus a constant potential is maintained.

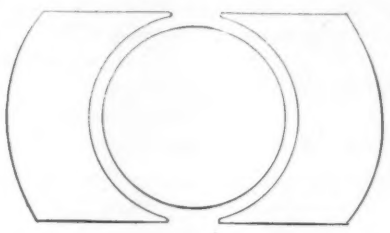


Fig. 3.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

The "armature characteristic" IV., plotted in Fig. 7, was taken from the machine of the above sort, built with cast iron fields. The cross section of the field cores proved on trial to be too small, and became strongly saturated at full load,—while they were quite a little under the point of saturation at no load. This curious result for a constant potential generator was due to the increased magnetic leakage, produced as the series ampère turns on the field came up with the load. Saturation took place as the curve indicates, when the armature furnished a current of about 140 ampères, and no possible compounding could ever make this generator produce even approximately a constant potential, with variation of load. Steel cores of the same dimensions were substituted for the cast-iron cores. Saturation did not occur in them due to magnetic leakage. The pole corners were very thin, as in Fig. 2, and the "armature

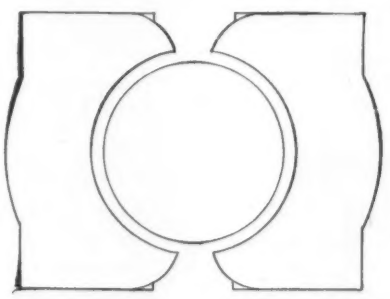


Fig. 4.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

characteristic" III. was obtained. The machine was then furnished with a shunt winding that produced a slightly smaller number of initial ampère turns than curve III. indicates as required to produce 125 volts, and with series turns at such a number that the total number of ampère turns on the field for any current developed by the armature is shown by the broken line drawn through curve III. It was under these conditions that the machine performed in the manner described above, and did not vary more than 5 per cent. from the normal E. M. F. on either side, or a total variation of 10 per cent. It was then almost entirely rebuilt. The armature was provided with a core that was considerably larger in cross section, and the maximum magnetic density used in it was 11,000 lines per square centimetre as against 20,000 used before. The lugs on the core were dispensed with, and the wires wound on the surface of the core. The poles were made of cast iron, and fashioned to accord more nearly with those in Fig. 3. The air gap required 10,000 ampère turns to set up the magnetization through it at no load, while the armature ampère turns were 8,000 at normal output, so that series ampère turns had only to be added to counteract the action of the ampère turns on the armature that lie between the double angle of lead to increase slightly the E. M. F. by the amount equal to the fall of potential through the armature caused by its resistance, and to compensate for the slight effect of the pole corners that still became saturated to a limited extent for the higher outputs. It should be remembered that the magnetic leakage that takes place between the adjacent north and south pole corners, one of which is strongly and the other weakly magnetized, plays an important part in saturating thin pole corners. It is evident that unless the "armature characteristic" is a straight line as in curve I., Fig. 7, that the machine cannot be made to regulate for constant potential with a high degree of refinement. The poles were again changed and shaped as in Fig. 4, when an "armature characteristic" given in curve I. was obtained, and the proper number of shunt and series ampère turns for a refined degree of regulation were readily decided upon. These experiments confirm what has been said above, and show how useless have been the attempts to diminish the air gap beyond certain limits.

It was shown at the start how we can calculate the actual magnetic densities in the air gap for any total magnetization through the armature, for any armature current. The results of the following experiments confirm the correctness of these methods. The diagrams in Fig. 8 give the values of the magnetic density at all points of the air

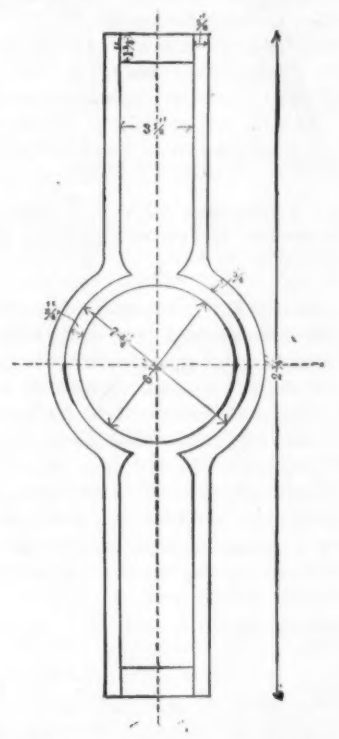


Fig. 5.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

gap of a generator producing 125 volts at the brushes and 80 ampères. The following are its dimensions and data:

Diameter of armature core	6.25 inches
Length of armature core	12 "
Diameter of bore of poles	7.19 "
Double depth of air gap	.94 "
Armature sections	50
Turns per section	2
Resistance of armature	.06 ohms.
Poles shaped as in Fig. 3,	
Shunt turns on field	6,400
Field current, on load, 125 volts	1.48
Field current, full load, 125 volts	2.10
Speed	1,600

Carbon brushes used without lead.

The "armature characteristic" curved considerably, indicating that the pole corners become saturated. It is evident, too, that the normal magnetization in the pole corners in addition to the magnetic leakage, which is greater there than anywhere else, produced saturation in all pole corners, even with no current in the armature. For at full load there were 4,000 ampère turns on the armature, while 4,000 series ampère turns had to be added to the field that produced 125 volts at no load to keep the E. M. F. the same.

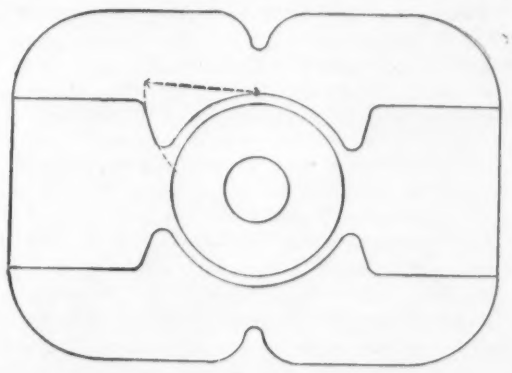


Fig. 6.—Ryan's Experiments on the Relation of the Air Gap to the Shape of the Pole Pieces.

Therefore at full load we have the same number of ampère turns acting through the weakened pole corners as at no load, and the total amount of magnetization has only been increased five per cent. to compensate for the resistance of the armature conductors. The conditions, however, are not the same, for there are just 4,000 more ampère turns to cause magnetic leakage at the pole corners, so that on the whole the magnetization in them is increased. This increase of magnetic density in them greatly increases their magnetic resistance, for they are saturated to begin with. It is on this account that we find the magnetization under the weakened pole corners diminished, when apparently the forces acting have not been changed. The magnetiza-

tion under the strengthened pole corners through the air gap is increased more than it is diminished by the effect of the added magnetic leakage, through the 8,000 additional ampère turns that act to produce magnetization by this route through the armature.

In Fig. 9 the diagrams show the magnetic action of the

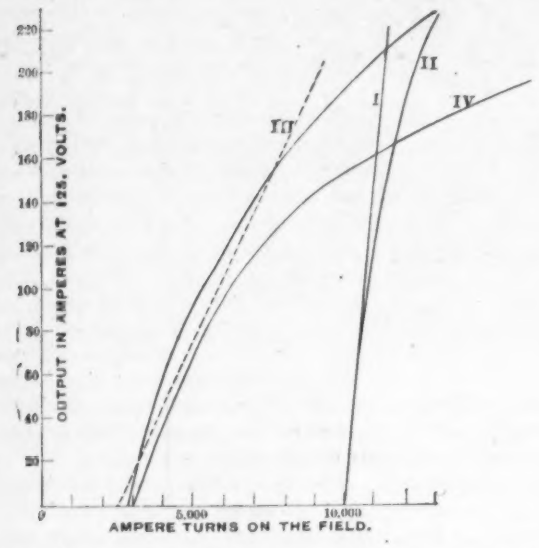


FIG. 7.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

armature of a 10 h. p. 110-volt motor, with poles fashioned as in Fig. 6. Measurements of the magnetic leakage were made on this motor, and the results indicate that the shape given to the pole corners avoided saturation in them even at full load. The double angle of lead was almost 60 degrees. The ampère turns embraced by it on the armature were partially compensated for by nine series turns on each of the consequent fields. The remainder of the armature ampère turns that lie between the double angle of lead served to weaken the field by just the amount required to produce a constant speed. The following figures give additional data on this motor:

Diameter of armature core	8.33	inches.
Diameter over all	9	"
Bore of poles	9.38	"
Double air gap	1.05	"
Shunt turns on field	2,200	
Shunt current at 110 volts	3.55	
Ampère turns on field at 110 volts	7,800	
Ampère turns on armature at full load	5,750	
Armature sections	48	
Turns per section	3	
Speed	1,200	

The ampère turns required to set up 2,600 lines per square centimetre through a distance of 1.05 inches or 2.64 centimetres in open air—

$$\frac{2{,}600 \times 2.64}{1.26} = 5{,}600.$$

This is the number of field ampère turns that exerted their magnetizing force between the pole faces through the armature. The ampère turns acting through the weakened pole corners are, therefore, very near zero, which is entirely corroborated by the fact that the magnetization was observed to be zero at this point. See full load curve in Fig. 9. Through the strong pole corners the ampère turns acting were the 5,600 of the shunt ampère turns + the 720 of the nine series turns + the armature ampère turns, 5,750—twice the ampère turns between the double angle of lead, 2 [.3 × 5,750], or 3,400 = 8,670, which will produce a magnetic density through an air gap of 2.64 centimetres depth of

$$\frac{8{,}670 \times 1.26}{2.64} = 4{,}100,$$

while the actual magnetic density measured at this point was 3,950, an agreement within the possible limit of error.

In Fig. 10 are given curves showing the magnetic performance of an armature, with its conductors laid in deep narrow grooves, as shown in Fig. 12. The clearance on each side was one-sixteenth of an inch, making the double

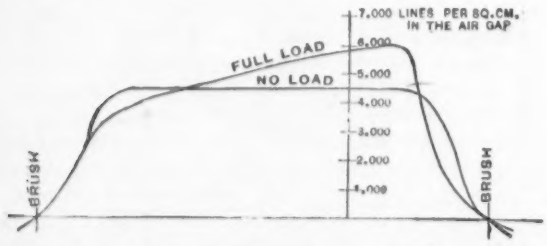


FIG. 8.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

air gap one-eighth of an inch. Additional dimensions are as follows:

Diameter of the armature core	6	inches.
Length of armature core	6	"
Resistance of armature	.34	"
Number of sections	64	
Turns per section	3	
Output, ampères	20	
Output, volts	100	
Speed	1,800	

Curve I., in Fig. 10, shows the distribution of magnetization at 112 volts, no current, a speed of 1,800, and a field excitation of 2,600 ampère turns. Curve II. shows the magnetic distribution for an output of 97 volts and 24 ampères, at a speed of 1,800, and a field excitation of 2,600 ampère turns. Curve III. shows the magnetic distribution at an output of 40 volts and 20 ampères, at a speed of 1,800, with a field excitation of 750 ampère turns. This same excitation when the armature furnished no current produced an E. M. F. of 48 volts, at a speed of 1,800 revolutions. The poles were shaped as in Figs. 11 and 12, but modified as explained below. In making these experiments carbon brushes were used, and their position maintained at the normal diameter of commutation. An average magnetic density in the air gap of 3,400 lines per square centimetre was required to produce an E. M. F. of 112 volts. The grooves on the armature in which the conductors were placed occupied one-half of the armature surface, so that the actual magnetic density in the air gap was 1.8 times this average magnetic density. The ampère turns required to set up this magnetic density in the air gap were

$$\frac{.125 \times 3.54 \times [3{,}400 \times 1.8]}{1.26} = 1{,}520,$$

which is the number of field ampère turns whose magnetizing force is impressed between the pole surfaces through the armature when it furnishes 112 volts and no current. The ampère turns on the armature at a current of 24 ampères are

$$\frac{2 \times 64 \times 3 \times 12}{2} = 2{,}300,$$

as against 1,520 impressed by the field. Under these circumstances the magnetism under the weakened pole corners is reversed, as is also clearly indicated by curve II. in Fig. 10, or the curve *C, E, D, F, C*, in Fig. 11. This curve also shows that the magnetic density under the strong pole

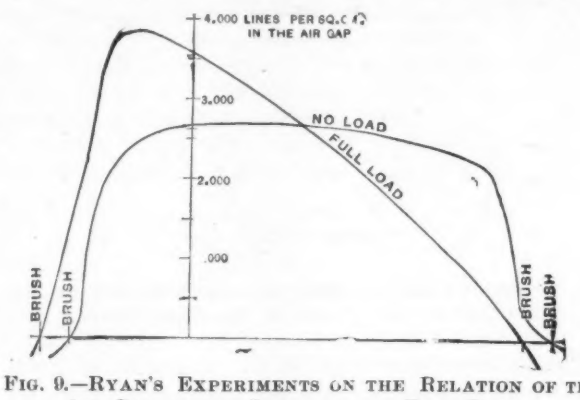


FIG. 9.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

corners was 5,100 lines per square centimetre. Now, in building this machine, six longitudinal slots, 1¼ inches deep, were cut in each pole immediately back of the surface, which enables us to be sure of the exact densities in the pole corners for a given distance. For a depth of 1¼ inches immediately back of the pole faces, these slots took up one-half of the cross section of the poles. Then a density, therefore, of 5,100 really means a density of 10,200 or a strong saturation for a distance of 2½ inches in the cast iron of the poles. The magnetizing force required to produce 10,200 lines per square centimetre through cast iron is 200 per centimetre length. Therefore

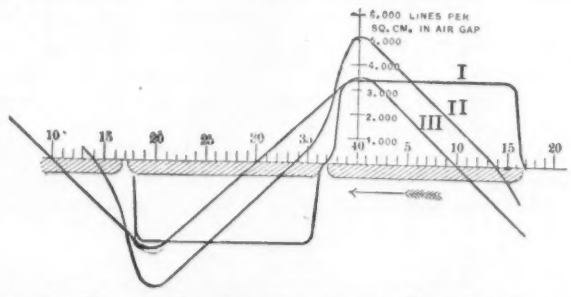


FIG. 10.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

the ampère turns required to establish this density through 2½ inches are

$$\frac{2.5 \times 2.54 \times 200}{1.26} = 1{,}000.$$

The total number of ampère turns acting to produce magnetization through these strong pole corners was the sum of the field ampère turns that impressed magnetizing force from pole face to pole face through the armature, and the ampère turns on the armature covered by the poles. The poles cover approximately 85 per cent. of the armature surface, making this value: 1,500 × [2,300 × .85] = 3,400. Of this number, as was just shown, 1,000 were utilized in producing the magnetic density of 5,000 through the saturated portion of the poles. The remaining 2,400 ampère turns exerted their magnetizing force in producing the average magnetic density of 5,100 through the air gap and afford another opportunity of checking these ideas of the action of the armature on the field. For the ampère turns required to set up an average magnetic density of 5,100, through the air gap under consideration, were

$$\frac{[1.8 \times 5{,}100] \times .125 \times 2.54}{1.26} = 2{,}300,$$

which checks with the above value as well as could be expected. When the armature furnished 24 ampères, the E. M. F. at the brushes was 97 volts, while with no current it was 112 volts. Of this drop of 15 volts, 8 are accounted for by the resistance of the armature, and the extra 7 were caused by the saturated pole corners. By operating this same machine at an E. M. F. at which the pole corners could not saturate with normal output of current, we have demonstrated for us in a very striking manner that the armature ampère turns cannot change the total magnetization established through the armature by the field when the pole corners do not saturate. The E. M. F. with the arma-

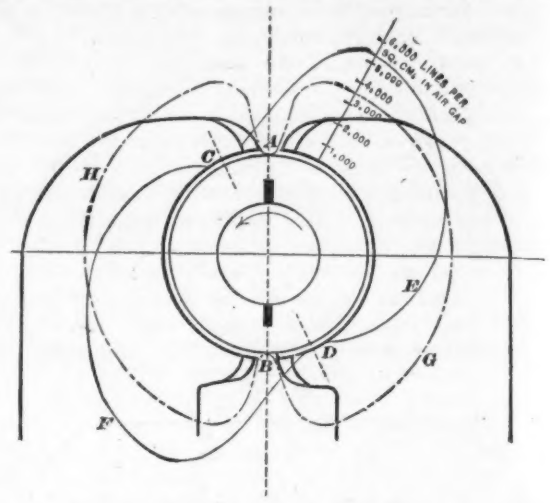


FIG. 11.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

ture current at zero was brought to 48 volts with a separate field excitation of 750 ampère turns. Then when the armature was allowed to furnish 20 ampères the E. M. F. at the brushes dropped to 40 volts. Of this drop of 8 volts, 7 were produced by the resistance of the armature. Yet the field is powerfully distorted by the armature current, as may be seen by reference to curve III., Fig. 10, or curve *A, D, C, B* in Fig. 12. Even with this very great rearrangement of the magnetization produced by the armature current, the total magnetization set up by the field is practically unchanged. The difference of potential on the commutator between the points *A, B*, Fig. 12, was observed to be 72 volts. This excess of E. M. F. over that which was produced at the brushes the figure shows clearly to be due to the magnetization produced by the armature through itself and the strengthened pole corners. The points where the field is zero are at *A, B*. They mark the diameter through which the ampère turns encountered on the armature are just equal and opposite in action to the ampère turns of the field that impress a magnetizing force between the pole faces through the armature. A simple computation will show that this is true. The field ampère turns that impress magnetizing force between the poles when the armature produced an external E. M. F. of 48 volts are

$$\frac{1{,}520 \times 48}{112} = 650.$$

The ampère turns on the armature opposed to the magnetization set up by the route *A, B*, are $\frac{12}{40}$ of the total number of ampère turns on the armature [see Fig. 12], or

$$\frac{12 \times 64 \times 3 \times 20}{40 \times 2} = 576.$$

This is a fair agreement when we consider the accuracy with which the original data may be determined.

Mr. Esson in his valuable paper, above referred to, discussed the requisite features for a generator for constant current, with closed coil armatures, in which regulation is effected by shifting the brushes. He stated that the field

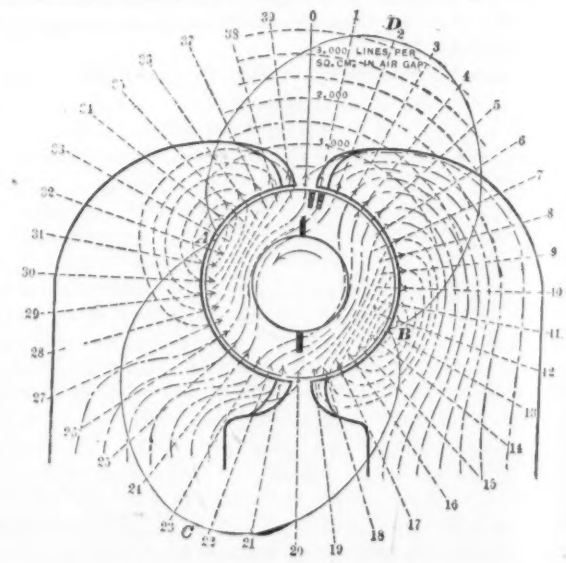


FIG. 12.—RYAN'S EXPERIMENTS ON THE RELATION OF THE AIR GAP TO THE SHAPE OF THE POLE PIECES.

should be uniform at all points, under the poles, and that the armature core should be saturated. These statements are a little misleading. The magnetizing force impressed by the field ampère turns must be uniform at all points between the pole faces. This is accomplished by proportioning the poles so that the strongly magnetized pole corners will not become saturated when the brushes have their extreme position for the development of the highest E. M. F. that the machine is to produce. The air gap is made of such a depth that the ampère turns required to set up the magnetization through the armature, without current, and for the production of the highest E. M. F. that the machine

will be called on to give, shall be a little more than the armature ampère turns when it furnishes its normal current. Then as long as the brushes are kept under the pole faces the non-sparking point will be wherever the brushes are placed. This will be the case whether the armature is or is not saturated. A practical demonstration is found in the following experiment. A Siemens & Halske dynamo with magnet and armature cores, whose shape and dimensions are shown in Fig. 5, was used.

Length of armature core	7.25 inches.
Number of armature sections	56
Turns per section	6
Revolutions	1,000
Output in volts	50
" " ampères	30

The field was separately excited with 4,000 ampère turns on each of the sets of consequent poles. Regulation could then be effected for a constant current in the armature of 22 ampères by shifting the brushes from no E. M. F. to 35 volts without the slightest sparking even when metallic brushes were used. Within this limit the pole corners did not saturate. The field cores were wrought and the yokes cast iron. When the armature circuit was broken, it was found that the field excitation of 4,000 ampère turns produced an E. M. F. of 50 volts. The magnetic density in the field cores, including leakage, was only 11,000 lines per square centimetre. Therefore, of the 4,000 ampère turns on the field not more than 200 were applied in setting up the magnetization from pole face to pole face through the field cores. It is safe to assume, then, that of these 4,000 ampère turns, 3,800 were active in producing a magnetizing force impressed uniformly over the pole faces through the armature. This same value is obtained by the method adopted in the previous cases, that is by calculating the magnetic density in the air gap when 50 volts were developed, and then deducing the number of ampère turns required to establish such a magnetic density through a 1½ inch air gap. As to the armature, when it produced 22 ampères its ampère turns numbered

$$\frac{2 \times 56 \times 6 \times 11}{2} = 3,700,$$

or an excess of 100 ampère turns impressed by the field over and above those on the armature. As long as this same number of ampère turns was maintained on the field it was not possible to regulate for a constant current of a lower or a higher strength without sparking. The impressed field ampère turns are in excess of the armature ampère turns by that amount which is just sufficient to produce a weak positive field that will reverse the current in the coil when its terminal bars at the commutator pass under the brush. When regulation is effected by this means it is seen that all pole corners are alike magnetized, and at the centre of the pole faces the magnetization is zero when the machine is short-circuited. At full output, at the highest E. M. F., the magnetization under the one set of pole corners is almost zero, and under the other set it is at the maximum value that is ever obtained. In a generator of this type, when the poles are made stout enough at all points, the total amount of magnetization through the armature, at all loads, will remain at a constant value. When used for operating long arc lamps a "drooping characteristic" can better be obtained by saturated field cores than by saturated pole corners and armature core.

What has been said of dynamos applies equally well to motors, the only difference being that the non-sparking points are on opposite sides of the diameter at which magnetization is zero in the air gap. This is due to a well known cause. In a motor the armature rotates in an opposite direction when field and armature currents remain the same as in a dynamo. The E. M. F. of self-induction caused by the reversal of the current in a circuit has not changed, while the E. M. F. developed in the coil by the field has changed sign with the change of the direction of rotation. The result is that the reversal of the current in an armature section must take place in a weak field of an opposite sign in a motor from what it does in a dynamo, when sparking is to be avoided entirely.

The action of the current in the armatures of multipolar dynamos and motors will be the same as that found for two pole machines.

In view of the importance of the subject treated in this paper, it was voted on motion of Mr. J. Stanford Brown that its discussion be continued at a future meeting. Members who may not be able to attend, and who are interested in the matter, are requested to send to R. W. Pope, Secretary, 12 West 31st street, any communications which they may wish to have incorporated in the discussion.

Electric Road at Escanaba.

Escanaba, Mich., is a thoroughly progressive town with a population of 8,000. Its streets are wide and well paved, and from its immense ore docks, perhaps the largest in the world, large shipments are made which make the tonnage greater than from any part of the country, except New York.

Under such conditions, Escanaba could not of course permit its sister towns to surpass it in facilities for rapid transit, and nothing less than the latest electrical equipment would satisfy the present desires of the community. The road, which was recently completed and formally opened for traffic on Sept. 13, is said to reflect credit on its owners and others concerned in its construction. It extends from the railway station on Stephenson avenue about three-quarters of a mile, and thence through Ludington street for a distance of a mile and a half. The latter street is the main business thoroughfare, and is lined throughout its entire length with the principal stores of the city.

At the opening of the road the scenes which have become so familiar were repeated. Crowds of passengers, enthusiastic citizens and delighted owners all testified their satisfaction with what is fast being recognized as the only method of rapid transit, suitable alike for cities and villages. The track is laid with 45-pound Johnson girder rails and the rolling stock consists at present of two Pullman cars mounted on Hubbard trucks, manufactured by the McGuire Manufacturing Company. The electrical equipment of each car consists of one 20-h. p. single reduction Westinghouse motor. All the line material was furnished by the Electric Merchandise Company, Chicago, and the overhead work presents a neat and handsome appearance. The cars will be heated during the coming winter with the Burton electric heaters, thus making the system purely electrical. The track was laid under the care of James B. Moran, who is to be the manager of the road, and the installation at the power house, together with the construction of the overhead work, was in charge of Mr. J. F. McBeth.

The president of the company is Mr. James Lillie, of Kankakee, Ill., and at his invitation Mr. J. L. Barclay, of the Westinghouse Electric and Manufacturing Company; Mr. Edward Halliday, president of the Cairo Electric Railroad; Mr. W. R. Mason, general manager of the Electric Merchandise Company, and others interested in electric traction attended the formal opening of the road and witnessed the successful inauguration of a rapid transit service which will doubtless result in hastening the growth of the prosperous little city.

The Pittsburgh Meeting of The American Street Railway Association.

The tenth annual meeting of the American Street Railway Association will be held at the Monongahela House, Pittsburgh, Pa., the third Wednesday in October (the 21st), 1891, commencing at 10 o'clock A. M., and continuing three days.

The meeting will, from present indications, be much more largely attended than any preceding. Special committees will report on the following subjects: "A Perfect Electric Motor;" "A Year's Progress of Cable Motive Power;" "Public and State Treatment of Corporations. No. 3;" "The Dependent—Overhead or Underground—System of Electric Motive Power," and "The Independent—Storage or Primary Battery—System of Electric Motive Power." Notice has been received by the secretary from the president of one of the member companies that a special paper will be read, under the following title: "Standards in Machinery and Appliances for Electric Railways."

The Local Committee of Arrangements, of which John G. Holmes, Esq., president of the Citizens' Traction Company, is chairman, has chartered for the week of Oct. 18-25 a double-decked excursion boat, which will be moored to the wharf alongside the Monongahela House, to be used for the exposition. Heavy supplies will be placed on the lower deck, and lighter ones on the upper. The boat will be suitably decorated, and lighted in the evening, and will be made a pleasant and interesting place for the exhibition of supplies.

The Pittsburgh street railway companies have not yet fully completed the arrangements for the special entertainment of those in attendance. Preparations for two excursions are under way, and they will be of a very enjoyable character. A handsome souvenir of the meeting is being prepared.

The Boston Lines Committee, Central Traffic Association, New York and New England Passenger Lines Committee, Southern Passenger Association and Trunk Line Association have united in granting the courtesy of the special rate of a fare and one-third for the round trip to all, including friends and members of the families of gentlemen in attendance at the Convention. The territory to which the concession applies is all of the United States except the Western and Pacific Coast States and Michigan.

The Practical Efficiency of Telegraphic Apparatus.

The following table relating to the "efficiency" of the various telegraph instruments employed by the French Post Office may be of interest. The figures are taken from an article in *La Lumière Electrique*. A message is reckoned at 20 words, and each word at 7.5 letters:

Apparatus.	Average number of messages per hour.	Number of operators.	Average number of messages per hour per operator.
Morse	25	2	12.5
" (duplex)	50	4	12.5
Sounder	40	2	20
" (duplex)	80	4	20
" (quadruplex)	160	8	20
Wheatstone	100	10	10
" (duplex)	200	18	11
Delany (quadruplex)	160	8	20
Baudot (quadruplex)	160	10	16
Hughes	50	4	12.5

Electric Heating.

BY MARK W. DEWEY.

Very little has been done up to the present time in heating by electricity, and yet enough has been accomplished to demonstrate its practicability and its superiority over all other modes of heating. The common belief is that heating by electricity would be too costly. It is generally conceded that in all other particulars it is superior to other modes of heating; and when electricity is generated a little cheaper than it is at present that objection will be removed. The only objection, therefore, is that it is not economical. This was exactly what was said about electric lighting when it was first proposed, but after it came into use it was found that it could be supplied as cheaply as gas or other illuminants, and to-day it is used in all parts of the world, and people cannot speak too highly of its merits.

One well known inventor, while he admits that electric heating is undoubtedly the most convenient and the ideal method of artificially warming our places of habitation, has said that it will not be economical until we can transform the heat in the coal directly into electricity without the intervention of boilers and engines. This inventor is wrong, and certainly could not have examined the subject fully. Even if we are compelled to employ the steam engine in the generation of electricity for heating, as in many cases at present, when we cannot get water power, heating by electricity is just as economical as heating by coal. We need not wait for the time, though it may be close at hand, when electricity will be generated directly from the heat of coal; if it is as economical to heat by electricity now, the immense advantage possessed by this mode of heating over other modes should and will soon give it the preference.

The same inventor said, although it is not understood why, as will be seen further on, that electric heating costs nine times as much as ordinary heating, or that to heat by electricity it would be necessary to burn nine pounds of coal to get the heating effect of one pound. This he explains by the fact that under the best conditions we realize in electricity about one-tenth of the energy of the coal consumed, and when we turn that ten per cent. of electricity into heat we simply get nothing more than ten per cent.; therefore, to get electric heat equivalent to the heat in one pound of coal it is necessary to burn ten pounds. This inventor seems to have lost sight of the fact that when employing a coal furnace or stove for heating we get only about 40 per cent. of the energy of the coal, and that then we must use a superior and expensive grade of coal costing from three to six times as much as the grade of coal that can be consumed at a large generating or central station. It is possible for us to get 60 per cent. of the total energy as useful heat from a first-class furnace if carefully and properly regulated; but stoves do most of the heating in towns, and they give but one-fourth, or 25 per cent., of the total energy in useful heat. Three-fourths of the heat passes up the chimney. Air rushes through the crevices of doors and windows in draughts which are injurious to health.

We can get 10 per cent. of the heat energy expended at the central station, and in using a stove we may get 25 per cent. Electric heat, therefore, would cost two and a half times more than heat derived from the consumption of coal in a good stove, if the same grade of coal is used in both cases; but as the central station can and does use coal costing one-fourth or one-third of what we must pay for coal to burn in a stove, electric heat can be obtained as cheap as the heat obtained by means of a coal stove.

It is evident from the above that electric heat is as economical as the heat ordinarily derived directly from coal, but when we consider the numerous advantages of electric heating it appears to be more economical still. Take, for instance, a house heated by electricity in a town. Let the current come from the central station and heat coils of iron wire. These coils are very cheap, may be placed in any part of the house and arranged in almost any conceivable and desirable way to produce the best results for heating or cooking purposes. These coils can be placed just under or around the vessel holding the article to be cooked or baked. Less heat than usual would be required, for no soot would collect upon the bottom of the containing vessel. The fire risk would be much less than at present, as the wire never need be hot enough to cause fires or can be easily and completely protected. The heat supply can be turned on or off instantly; thus there will be no loss of fuel when the need of heat has ceased. This applies with great force to summer use. In heating, cooking or baking, the temperature can be kept uniform or controlled as desired. In cooking or baking, many things are spoiled and wasted because the heat cannot be regulated as desired or appears to be different than it really is. Many regulators have been devised for the automatic regulation of coa heaters, but none of them accomplish their purpose fully for the reason that a coal heater cannot be automatically regulated except in a small degree. We must visit the furnace or stove now and then, supply it with coal, rake down the ashes, carry them out, clean the soot out of the flues so that it will have draught, and many other things. None of these things would be necessary with an electric heater. It can be thermostatically regulated perfectly the year around, and when the weather is warm enough or whenever from any cause the temperature of a house is raised above the point beyond which artificial or electric heat is not required, it will shut itself off and there

will be no waste whatever; when the temperature falls below the predetermined point the current will be automatically put on again so that the temperature will be kept uniform and healthful. A meter can be placed in the circuit to the heater which will register perfectly the amount of current consumed in producing the heat used, which of course is all that must be paid for. Coal stoves or furnaces do not possess this great advantage, and are often in use and wasting energy when an electric heater would be consuming nothing, and, not being in use, are not worn out as quickly as a stove. A coal stove is often run continuously during the summer season when two or three hours per day would be sufficient. This is done for various reasons; sometimes to save time or the undesirable job of cleaning out the stove and building a new fire, which necessitates the handling of kindling wood, ashes and coal, which in turn produces more or less dust, smoke and gas; and sometimes the fire is kept not only for these reasons, but because the weather is liable to change or become rapidly cooler, and at a time when time cannot be conveniently spared; so we keep the fire going day after day, especially in the spring and the fall, although it is warm enough to dispense with it, because we expect the weather to grow cooler; and often it does, and then we feel repaid for the heat energy we have wasted because it has saved us from building a new fire. But very often the weather does not grow cooler for several days and sometimes not at all; then much heat energy is wasted. With electric heat this would not be so, for the simple turning of a handle or switch, more or less, if automatic regulation was not used, would be all that would be required to turn the heat off or on as desired. We would therefore not waste the heat half a day or an hour.

Without rising in the morning, a button touched at the bedside may be made to turn the heat on in any or all parts of the house. The nuisance of kindling, smoke, gas, ashes and soot will be abolished, and no stovepipes, chimneys, scuttles, shovels, ash-sifters, kindling wood, coal, or coal bins will be needed. Taking into consideration the cost of the articles above named, the trouble and fire risk, I am positive that electricity will not only be found as cheap, but much cheaper than heat supplied directly from coal as usual.

When the dynamo at the central station can be driven by water power as is done in very many places at present and will be done in the future at a great many more, or when the central station is at places, such as Scranton, where coal mines are situated, greater economy can be obtained. Water power can be supplied ten hours a day, at $20, and steam at $50 annually per horse power. In this case steam costs two and a half times as much as water.

It will be apparent from the above that electric heating would cost two and a half times as much as heating by

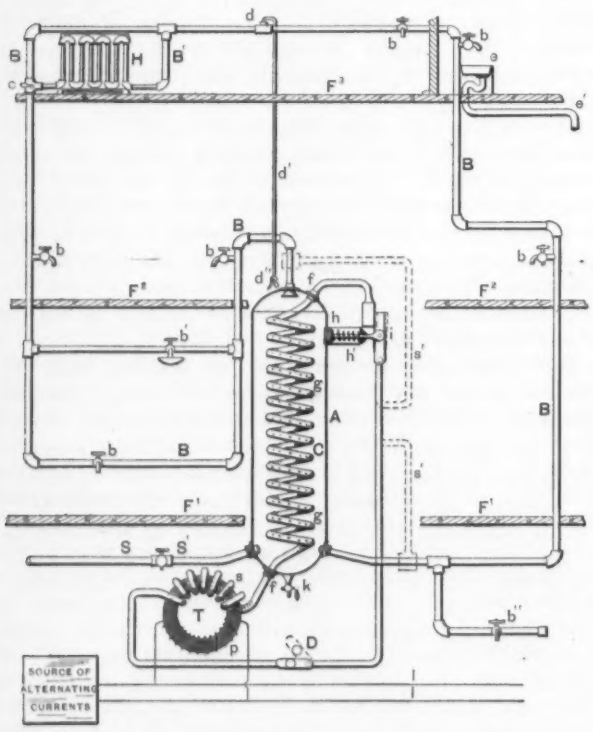


Fig. 3.—System of Electrically Supplying Hot Water.

stoves, if the same grade of coal was used in both cases, and in using water power to generate electricity the heat will cost the same as when produced in stoves, even neglecting the cost of the many articles above named that would be dispensed with.

Platinum wire has heretofore been used almost entirely for electric heating, but iron is as good and will be used in the future. The conductivity of soft iron is nearly as low as soft platinum, the ratio at the temperature of melting ice being as 20.73 to 18.03, and the cost nearly as 1 to 5,000.

Electric heating apparatus is much cheaper than other heating apparatus, as wires may be used in the place of pipes for conductors for the heat or the heating medium. No heat need be wasted, as each room can have its heater and though small will consume no more energy accordingly than a large heater.

Another thing to be noticed is, that the electric current for heating may be the same as for lighting. The electric lighting station can produce it; the same wires that conduct the current for your lamps, whether arc or incandescent, may conduct the current also for the heaters; in fact, all that is necessary is that sufficient current be furnished a consumer to supply both his lamps and heaters. One of the greatest advantages possessed by electricity over the ordinary stove for heating, from a commercial standpoint, lies in the fact that the same current that is utilized for heating can also be used for lighting and power, and the current generated for all those purposes may be transmitted to the various points of consumption over the same circuit. Instead of numerous small heat generators, such as furnaces and stoves, a single large generating station, equipped with modern appliances for the economical production of electrical energy, such as improved boilers, furnaces, triple or quadruple expansion compound engines constantly working at full capacity, and storage batteries to store the electricity when the consumption is low, would be sufficient to supply a district with all the heat that may be required, without mentioning light and power, at a cost to the consumer that will compare favorably with what he is now called upon to pay for the fuel, attendance, etc., required by the present crude and wasteful methods of heating employed by him. The large increase in the size and earning capacity of these stations, due to the vastness of the field to be occupied by electric heating, will also greatly reduce the cost of current.

With the encouraging progress that has been made in the direction of providing more efficient and satisfactory methods of utilizing the current so as to obtain the greatest amount of heat therefrom, the problem of successful heating by electricity is practically solved, and there is every reason to believe that the time is short before electric heating will be generally adopted.

It may be said further that it has been proved beyond a doubt that electric cars can be heated as economically by electricity as as by other means, and if electric cars, why not others, and also houses of all kinds where the electric current is used for lighting or other purposes?

One form of apparatus devised by the writer to render electric heating effective and economical is a floor or floor mat that can be electrically heated. This form of heater is capable of distributing the heat throughout the room or car in which it is placed more uniformly and exposes a large radiating surface to the atmosphere in all parts of the room or car. Floor mats are commonly used in street cars to prevent wear upon the floors and to keep persons from slipping. Mats the same or similar to those already in use are employed for the heater, the only essential requirements being that the mats be provided with heat radiating conductors and connected to suitable supply conductors.

These mats are perfectly safe and effective. A very low tension current is employed to heat the mats and this current is passed through them. They can be and are arranged in some cases so that it is impossible to touch the conductor of the mats, but even if the conductor in the mat is not protected or shielded it is utterly impossible to receive a shock by contact in any manner with the mat. In some cases, flexible steel coiled spring mats will be employed for the purpose, as they offer the required electrical resistance, expose a very great radiating surface, and are easily removed for cleaning purposes.

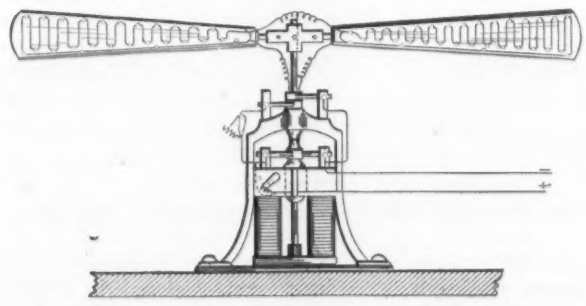


Fig. 2.—Electric Heating Apparatus.

By the employment of a mat heater the disadvantages common to the usual modes of artificial heating are removed, these disadvantages being due to the fact that the heat is concentrated in a particular locality, and therefore is not equally distributed as it should be since the space in the vicinity of the old heater must be heated to an undesirable degree in order that remote localities may be raised to a comfortable temperature.

The large exposed radiating surface area of the mat heater will enable it to develop and radiate a great amount of heat without becoming very hot; that is, not hot enough to burn wood, leather or rubber in contact with it. It will be unnecessary to raise the heat in the mat above 100 degrees Fahrenheit on the coldest day in the winter to produce a comfortable temperature. This is not only because of the extended radiating surface of the heater, but on account of its position upon the floor. The heater does not take up valuable room, and in storage battery cars allows the entire space under the seats to be used for the batteries. These mat heaters are especially adapted for heating rooms and halls in houses. They may be made entirely of nickel or of bronze and formed into a grating of some beautiful design, which can rest upon tiling or marble and have its upper surface level with the floor. In order to prevent undue heating of the mats or to keep their temperature below the igniting point of wood, leather, etc., an automatic heat regulator is provided in the shape of a thermostatic cut-off or current controller, arranged so that it may be adjusted for any desired degree of temperature, and to cut out the

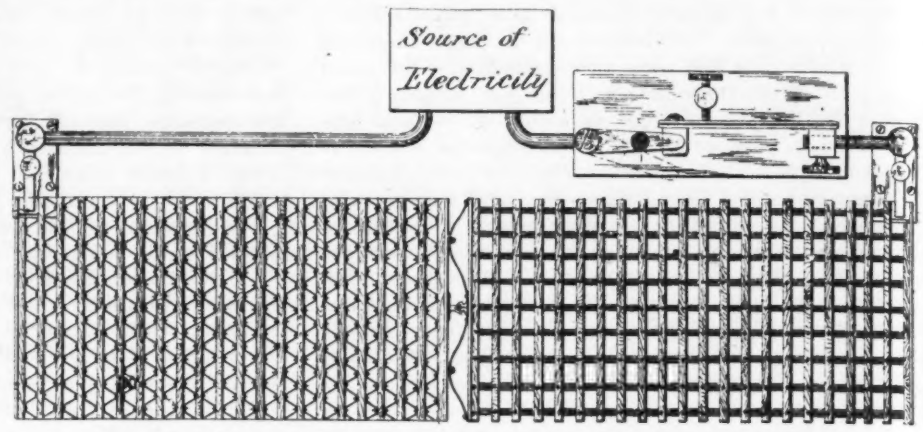


Fig. 1.—Floor Mat Arranged for Electric Heating.

mat when the temperature rises slightly above that predetermined.

In the accompanying illustrations, Fig. 1 represents a top view of two floor mats coupled together and connected with a suitable source of electricity to heat the mats, and a thermostatic current controller in the circuit to regulate the heat. Two different styles of mats are shown in this figure. The conductors leading from the source of electricity to the mats are of large cross-section and better conductivity than the mats, consequently the heat produced by the current is located in the mats. Both of these mats are formed of conducting and non-conducting material, as iron and wood, the conducting material forming the heat radiating electric conductor and the non-conducting material forming the shield or protecting part. The conductor in the mat on the left of the figure is formed of zigzagged strips of iron or other metal placed between slats of hard wood thicker than the width of the strips, thus forming a shield for the strips or preventing contact with them. The strips of metal are connected by rivets extending through the slats. On account of the form of construction of this mat it is rigid and stiff, but the mat shown on the right of the figure is flexible, as coiled springs extend lengthwise through the slats and form the radiating conductors. The mats are provided with suitable terminals to which the terminals of the circuit are connected. They can be quickly and easily connected to and disconnected from the circuit when desired by means of specially designed clamps.

Fig. 2 represents a combined fan, or means to keep the air in motion, and an electric heater. When the air surrounding a heating conductor is kept in rapid motion the conductor is able to produce more heat in a given time, and a heat conducting medium, as asbestos or fire-clay, surrounding the conductor is unnecessary and may be dispensed with. With this heater all parts of the room are heated uniformly. It also ventilates the room and maintains a healthy atmosphere. In warm weather the heater may be cut off and the fan used for ventilating purposes only. Many forms of apparatus may be devised having this principle; for instance, the heating conductor need not be mounted upon the fan but on the stationary support in proximity to the fan, or the heating conductors may be arranged in a suitable manner in a pipe or flue, with a fan at one end to cause a current of air to pass through it.

Fig. 3 illustrates a system for electrically supplying hot water for domestic or heating purposes, or both. With this apparatus the water is supplied to the boiler *A* by the pipe *S*. The water is distributed from and to the boiler through the house by the circulating pipe *B*. *H* is a hot water radiator connected with the pipe for giving out heat. By means of the cock, *c*, the water may be shunted around the radiator when heat is not desired. Many radiators may be connected with the pipe either in series or otherwise. When the system is used largely for heating purposes, although it is possible, it is not thought to be advisable to use the water for domestic purposes, as the temperature of the water becomes lower and the radiators may not give out the amount of heat desired. The water is drawn from the pipe at the faucets *b*. The water is preferably heated in the boiler by means of a perforated coiled pipe located within the same and connected with the terminals of a suitable source of electricity, which is shown in the figure as generated by an inductional transformer *T*. The current is automatically regulated by the pressure of the water in the boiler through the current controller *i*. Although not shown, this controller is

made adjustable so that the water may be heated to any degree of temperature desired. When the water becomes too hot or rises above the temperature desired, the controller is moved to break the circuit, and when the water becomes cool again the decrease of pressure in the boiler allows the controller to close the circuit. In some cases the heating current is also passed through the distributing pipe, *B*, which then becomes a heating conductor also. If preferred, the water may be heated by the passage of the current through the distributing pipe alone. In the latter case the boiler may be dispensed with. The heating of the distributing pipe may be done, however, for the purpose of assisting the boiler heater in maintaining a constant temperature.

Many forms of electric heaters or radiators may be employed for heating purposes that are directly heated by the electric current without using water. Such radiators may be made both efficient and light, and much more attractive than steam or hot water radiators and will not produce noise or give out unhealthy gases.

Electric heaters may be used to heat air which may be distributed to or circulated through rooms in houses by

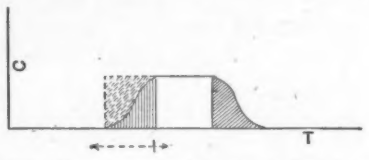


Fig. 1.—The London-Paris Telephone.

pipes and registers similar to those used with our coal furnaces, which are so hard to feed, clean and regulate.

Cooking stoves may be electrically heated and automatically regulated. Such stoves may be constructed so that the oven alone may be heated or any other part of the stove without heating the entire stove. The oven may contain an incandescent lamp and be provided with windows to enable the cook to see the contents without opening the door and allowing the heat to escape and the contents to be spoiled.

Those who admire the bright fire in a grate can enjoy it without the consumption of coal, wood, or other fuel by placing the incandescent lamps or an arc lamp beneath a body of glass, formed and covered, if need be, to represent a bed of coals or pieces of log wood, placed in the fireplace. The back and sides of the fireplace may be formed of mirrors if desired to magnify the effect, and if the heat is also desired a small flat electric heater may be placed beneath, back of the ash guard.

The London-Paris Telephone.*

BY W. H. PREECE, F. R. S.

1. I have already on two occasions, at Newcastle and at Leeds, brought this subject before Section G, and have given the details of the length and construction of the proposed circuit. I have now to report not only that the line has been constructed and opened to the public, but that its

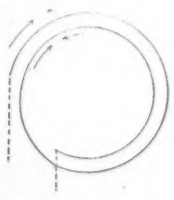


Fig. 2.—The London-Paris Telephone.

success, telephonic and commercial, has exceeded the most sanguine anticipations. Speech has been maintained with perfect clearness and accuracy. The line has proved to be much better than it ought to have been, and the purpose of this paper is to show the reason why.

The lengths of the different sections of the circuit are as follows :

London to St. Margaret's Bay	84.5	miles
St. Margaret's Bay to Sangatte (cable)	2.3	"
Sangatte to Paris	199	"
Paris underground	4.8	"
Total	311.3	"

The resistances are as follows :

Paris underground	70	ohms.
French line	294	"
Cable	143	"
English line	483	"
Total (*R*)	693	"

The capacities are as follows :

Paris underground	0.43	microfarads.
French line	3.33	"
Cable	5.52	"
English line	1.32	"
Total (*K*)	10.62	"

$$693 \times 10.62 = 7{,}359 = K\ R.$$

A product which indicates short speeds should be very great.

2. *Trials of Apparatus.*—The preliminary trials were made during the month of March between the chief telegraph offices of the two capitals, and the following microphone transmitters were compared :

Ader	Pencil form.
Berliner	Granular " (Hunnings.)
D'Arsonval	Pencil "
De Jongh	" "
Gower Bell	" "
Post Office switch instrument	Granules and lamp filaments.
Roulez	Lamp filaments.
Turnbull	Pencil form.
Western Electric	Granular.

*Paper read before the British Association, in Section G, at Cardiff, August, 1891.

The receivers consisted of the latest form of double-pole Bell telephones with some Ader and D'Arsonval receivers for comparison. After repeated trials it was finally decided the Ader, D'Arsonval, Gower-Bell (with double-pole receivers instead of tubes), Roulez and Western Electric were the best, and were approximately equal.

These instruments were, therefore, selected for the further experiments, which consisted of using local extensions in Paris and London. The wires were in the first instance extended at the Paris end to the Observatory through an exchange at the Avenue des Gobelins. The length of this local line is seven kilometres. The wires are gutta-percha covered, placed underground, and not suitable for giving the best results.

The results were, however, fairly satisfactory. The wires extended to the Treasury in London by means of the ordinary underground system. The distance is about two miles, and although the volume of sound and clearness of articulation were perceptibly reduced by these additions to the circuit, conversation was quite practicable.

Further trials were also made from the Avenue des Gobelins on underground wires of five kilometres long, and also with some renters in Paris with fairly satisfactory results. The selected telephones were equally efficient in all cases, which proves that to maintain easy conversation when the trunk wires are extended to local points it is only necessary that the local lines shall be of a standard not lower than that of the trunk line. The experiments also confirm the conclusion that the long distance speaking is solely a question of the circuit and its environments, and not one of apparatus. The instruments finally selected for actual work were Gower-Bell for London and Roulez for Paris.

The results are certainly most satisfactory. There is no circuit in or out of London on which speech is more perfect than it is between London and Paris. In fact, it is better than I anticipated, and better than calculation led me to expect. Speech has been possible not only to Paris, but

Fig. 3.—The London-Paris Telephone.

through Paris to Bruxelles, and even, with difficulty, through Paris to Marseilles, a distance of over 900 miles. The wires between Paris and Marseilles are massive copper wires specially erected for telephone business between these important places.

4. *Business Done.*—The charge for a conversation between London and Paris is 8s. for three minutes' complete use of the wire. The demand for the wire is very considerable. The average number of talks per day, exclusive of Sunday, is 86. The maximum has been 108. We have had as many calls as 19 per hour—the average is 15 during the busy hours of the day. As an instance of what can be done, 150 words per minute have been dictated in Paris and transcribed in London by shorthand writing. Thus in three minutes 450 words were recorded, which at 8s. cost five words for a penny.

5. *Difficulties.*—The difficulties met with in long distance speaking are several, and they may be divided into (*a*) those due to external disturbances and (*b*) those due to internal opposition.

(*a.*) Every current rising and falling in the neighborhood of a telephone line within a region, say, of 100 yards, whether the wire conveying it be underground or overground, induces in the telephone circuit another current, producing in the telephone a sound which disturbs speech, and if the neighboring wires are numerous and busy, as they are on our roads and railways, these sounds become confusing, noisy, and ultimately entirely preventive of speech. This disturbance is, however, completely removed by forming the telephone circuit of two wires placed as near to each other as possible, and twisted around each other without touching, so as to maintain the mean average distance of each wire from surrounding conductors, the same everywhere. Thus similar currents are induced in each of the two wires, but being opposite in direction, as

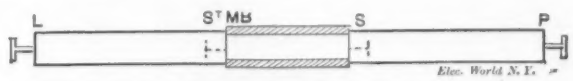


Fig. 4.—The London-Paris Telephone.

far as the circuit is concerned, they neutralize each other, and the circuit, therefore, becomes quite silent.

In England we make the two wires revolve completely round each other in every four poles, but in France it is done in every six poles. The reason for the change is the fact that in the English plan the actual crossing of the wires takes place in the span between the poles, while in the French plan it takes place at the poles. This is supposed to reduce the liability of the wires to be thrown into contact with each other by the wind, but, on the other hand, it diminishes the geometrical symmetry of the wires—so very essential to insure silence. As a matter of fact, contacts do not occur on well-constructed lines, and I think our English wires, being more symmetrical, are freer from external disturbance than those in France.

(*b.*) The internal opposition arises from the resistance *R*, the capacity *K*, and the electro magnetic inertia *L*, of the circuit. A current of electricity takes time to rise to its maximum strength and time to fall back again to zero. Every circuit has what is called its *time constant*, *t* (Fig. 1), which regulates the number of current waves which can be transmitted through it per second. This is the time the current takes to rise from zero to its working maximum and the time it takes to fall from this maximum to zero again, shown by the shaded portions of the figure, the duration of the working current being immaterial and shown by the unshaded portion. The most rapid form of quick telegraphy requires about 150 currents per second, currents each of which must rise and fall in $\frac{1}{150}$ of a second, but for ordinary telephone speaking we must have about 1,500 currents per second, or the time which each current rises from zero to its maximum intensity must not exceed $\frac{1}{3000}$ part of a second. The time constant of a telephone circuit should, therefore, not be less than .0003 second.

Resistance alone does not affect the time constant. It diminishes the intensity or strength of the currents only ; but resistance, combined with electro-magnetic inertia, and with capacity, has a serious retarding effect on the rate of

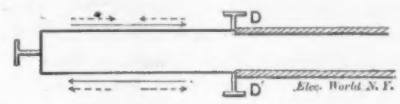


Fig. 5.—The London-Paris Telephone.

rise and fall of the currents. They increase the time constant and introduce a slowness which may be called *retardance*, for they diminish the rate at which currents can be transmitted. Now, the retardance due to electro-magnetic inertia increases directly with the amount of electro-magnetic inertia present, but it diminishes with the amount of resistance of the conductor. It is expressed by the ratio L/R, while that due to capacity increases directly, both with the capacity and with the resistance, and it is expressed by the product $K\ R$. The whole retardance, and, therefore, the speed of working the circuit or the clearness of speech, is given by the equation

$$L/R + K\ R = t,$$

or

$$L + K\ R^2 = R\ t.$$

Now, in telegraphy we are not able altogether to eliminate *L*, but we can counteract it, and if we can make $R\ t = O$, then

$$L = -\ K\ R^2,$$

which is the principle of the shunted condenser that has been introduced with such signal success in our post office service, and has virtually doubled the carrying capacity of our wires.

If in the above equation we make $L = O$, $K\ R = t$. This is done in telephony, and hence we obtain the law of retardance, or the law by which we can calculate the distance to which speech is possible. All my calculations for the London and Paris line were based on this law, which experience has shown to be true.

How is electro-magnetic inertia practically eliminated? First by the use of two massive copper wires, and secondly

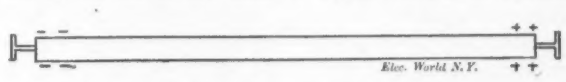


Fig. 6.—The London-Paris Telephone.

by symmetrically revolving them around each other. Now *L* depends on the geometry of the circuit, that is, on the relative form and position of the different parts of the circuit, which is invariable for the same circuit, and is represented by a coefficient, λ. It depends also on the magnetic qualities of the conductors employed and of the space embraced by the circuit. This specific magnetic capacity is a variable quantity, and is indicated by μ for the conductor, and by μ_0 for air. It depends also on the rate at which currents rise and fall, and this is indicated by the differential coefficient $d\ C/d\ t$. It depends finally on the number of lines of force due its own current, which cut the conductor in the proper direction; this is indicated by β. Combining these together we can represent the electro-magnetic inertia of a metallic telephone as

$$L = \lambda\ (\mu + \mu_0)\ d\ C/d\ t \times \beta.$$

Now, $\lambda = 2 \log d^2/a^2$. Hence the smaller we make the distance (*d*) between the wires, and the greater we make their diameter (*a*), the smaller becomes λ. It is customary to call the value of μ for air and copper 1, but this is purely artificial and certainly not true. It must be very much less than one in every medium, excepting the magnetic metals, so much so that in copper it may be neglected altogether, while in air it does not matter what it is, for by the method of twisting one conductor round the other the magnetization of the air space by the one current of the circuit rotating in one direction is exactly neutralized by that of the other element of the circuit rotating in the opposite direction. Now β, in two parallel conductors conveying currents of the same sense, that is flowing in the same direction, is retarding (Fig. 2), and is therefore a positive quantity, but when the currents flow in opposite directions, as in a metallic loop (Fig. 3), they tend to assist each other and are of a negative character. Hence in a metallic telephone circuit we may neglect *L in toto*, as I have done. I have never yet succeeded in tracing any evidence of electro-magnetic inertia in long single copper wires, while in iron wires the value of *L* may certainly be taken at .005 henry per mile.

In short metallic circuits, say of lengths up to 100 miles, this negative quantity does not appear, but in the Paris-London circuit this helpful mutual action of opposite currents comes on in a peculiar way. The presence of the cable introduces a large capacity and practically in the centre of the circuit. The result is that we have in each branch of the circuit between the transmitter, say, at London and the cable at Dover, extra currents at the *commencement* of the operation, which, flowing in opposite directions, mutually react on each other and practically prepare the way for the working currents. The presence of these currents is proved by the fact that when the cable is disconnected at Calais, as shown in Fig. 5, and telephones are inserted in series as shown, at D and D', speech is as perfect between London and St. Margaret's Bay as if the wires were connected across, or as if the circuit were through to Paris. Their effect is precisely the same as though the capacity of the aerial section were reduced by a quantity (M), which is of the same dimension or character as K. Hence our retardance equation becomes

$$R(K - M) = t.$$

Thus it happens that the London-Paris telephone works better than was expected. The nature of M is probably equivalent to about .0075 φ per mile, and, therefore, K should be also about .0075 φ, instead of .0156 φ per mile. This helpful action of mutual induction is present in all long circuits, and it is the reason why we were able to speak to Brussels, and even to Marseilles. It also appears in every metallic loop, and vitiates the measurements of electro-magnetic inertia and of capacity of loops. Thus, if we measure the capacity of a loop as compared with a single wire, the amount per mile may be 50 per cent. greater than it ought to be; while, if we measure the capacity of one branch of a circuit under the conditions of the London-Paris telephone line, it may be 50 per cent. less than it ought to be. This effect of M is shown by the dotted line in Fig. 1.

Telephonic currents, that is, currents induced in the secondary wire of an induction coil due to the variation of microphonic currents in the primary wire are not alternating currents. They do not follow the constant periodic law, and they are not true harmonic sine functions of the time. The microphonic currents are intermittent or pulsatory, and always flow in the same direction. The secondary currents are of the same sign, as are the currents in a Ruhmkorff coil, and as are the currents in high vacua with which Crookes has made us so familiar. Moreover, the frequency of these currents is a very variable quantity, not only due to the various tones of voices, but to the various styles of articulation. Hence the laws of periodic alternate currents following the sine function of the time fail when we come to consider microphones and telephones. It is important to bear this in mind, for nearly everything that has hitherto been written on the subject assumes that telegraphic currents follow this periodic sine alw. The currents derived from Bell's original magneto-transmitters are alternate, and comply more nearly with the law. The difference between them and microphones is at once perceptible. Muffling and disturbance due to the presence of electro-magnetic inertia become evident, which are absent with microphones. I tested this between London and St. Margaret's, and found the effect most marked.

7. *Lightning.*—A metallic telephone circuit may have a static charge induced upon it by a thunder cloud, as shown in Fig. 6. Such a charge is an electric strain, which is released when the charged cloud flashes into the earth or into a neighboring cloud. If there be an electro-magnetic inertia present, the charge will surge backward and forward through the circuit until it dies out. If there be no E. M. F. present it will cease suddenly, and neutrality will be attained at once. Telephone circuits indicate this operation by peculiar and characteristic sounds. An iron wire circuit produces a long swish or loud sigh, but a copper wire circuit like the Paris-London telephone emits a short, sharp report, like the crack of a pistol, which is sometimes startling, and has created fear, but there is no danger or liability to shock. Indeed, the start has more than once thrown the listener off his stool, and has led to the belief that he was knocked down by lightning.

8. The future of telephone working, especially in large cities, is one of underground wires, and the way to get over the difficulties of this kind of work is perfectly clear. We must have metallic circuits, twisted wires, low resistance, and low capacity. In Paris a remarkable cable, made by Fortin-Herman, gives an exceedingly low capacity, viz., only .069 φ per mile. In the United States they are using a wire insulated with paper which gives .08 φ per mile. We are using in London Fowler-Waring cable giving a capacity of 1.8 φ per mile, the capacity of gutta-covered wire being 3 φ per mile.

Closed Conduit System.

An interesting exhibit at the Frankfort Exhibition, says the London *Electrical Engineer*, is a novel and simple closed conduit system of electric traction by Messrs. Schuckert & Co., of Nürnberg. The closed conduit systems hitherto tested in practice in England comprise two kinds —that advocated by Mr. Lineff, in which a continuous conductor laid underground is drawn up into communication with the conductor sections, one after the other as the car proceeds, by the attraction of a magnet placed on the car; the other, advocated by Mr. J. Gordon, charges the conductor sections by a return insulated circuit actuated by magnets placed not in the car, but in a box under the pavement. Schuckert's system is of the first order, based upon the Lineff principle; but instead of using a continuous thin strip of iron, which is raised magnetically to make contact, Messrs. Schuckert employ iron filings, in the following simple way. The conductor sections are laid along in the roadway upon solid wood planks, embedded in the ground, under which is the main strip conductor. Each wooden plank is pierced downward at intervals along its length by taper holes of 1½ inches to 2 inches diameter, which have the smaller diameter at the top. Before laying the iron conductor rails over the planks, these holes are each partly filled with a handful of iron filings, which drop down upon the main conductor. As the tram passes, its magnet energizes the roadway beneath it, and the iron filings rise in a heap and make contact with the surface conductor, falling again as the car passes. The taper form of the hole prevents their continued contact after the car passes, and the number of holes and the mass of filings is said to obviate all difficulty with reference to contact or sparking.

Sketch of the Proceedings of Section A of the British Association at Cardiff.*

BY DR. OLIVER LODGE, F. R. S.

The unfortunate time of year selected for the Cardiff meeting was responsible for the absence of a good many of those whom we have grown accustomed to welcome at these annual gatherings, and letters of regret and explanation were numerous. The principal ingredient in the programme for this year was Astronomy, rather than Electricity; and, although the communications to Section A maintained their usual high level, and represented scientific work of a very high order, it may be admitted at once that to electricians in the narrow sense they were not specially attractive or important. Under these circumstances it is evidently just as well that the idea of constituting an Electrical Section, which has been several times mooted, has not received much support. Understanding that readers who were not present may nevertheless like some account of what went on in the Section I proceed to give a brief sketch.

The president's address, after dealing with color photography and one or two other discoveries of the year, advocated at some length the establishment of a national physical observatory or laboratory for quantitative and long continued physical research; especially for the exact determination of such physical constants as are required for practical purposes, to maintain the various standards in a state fit for use, and to arrange for the comparison and certification of authorized copies. After pointing out the advantages and use of such a permanent national institution, an institution which France and Germany already possess or are acquiring, the address lapsed into metaphysics.

Friday opened with a mathematical note by Prof. Andrew Gray, of Bangor, with reference to the Faraday rotation of the plane of polarization of light in a magnetic field. Sir W. Thomson had illustrated the matter by a chain of gyrostats, and shown how a rotation of some kind round the lines of force was essential to the explanation of the phenomenon. Prof. Gray now considers a chain of molecular magnets arranged along the lines of force and, applying to them Maxwell's electro-magnetic equations, obtains a differential equation for the propagation of radiation along the lines of force, which is the same as that obtained by Sir W. Thomson with the chain of small gyrostats, and which, therefore, gives the observed rotation of plan of polarization in the same way. Dr. Larmor remarked that probably any kinetic theory would lead to the particular term in the differential equation on which the rotation of the plan of polarization depended. No theory but a kinetic one would serve to explain the phenomenon, but kinetic theories would only differ in the particular kind of rotation postulated, whether material, ethereal, or vaguely magnetic.

The present writer then gave a preliminary account of some experiments he is making to ascertain the effect of a rapidly moving body on the ether in its neighborhood. It has long been a question whether the earth, for instance, moved freely through the ether without disturbing it in any way, or whether it dragged some of the ether with it. He proposes to attack the question by direct experiment, and to this end sends a beam of light, split into two equal portions, half of it with, and half of it against, the motion of a rapidly revolving disc or pair of discs. The two beams of light are then brought together and allowed to interfere. The observation consists in showing whether the system of interference bands shift their position when the discs are set into rapid rotation. If they do, it shows that one-half the light is accelerated, and the other half retarded, by the action of moving matter in its immediate neighborhood. The discs selected are a pair of plates of hammered Sheffield steel, one yard in diameter, clamped together, and mounted on a vertical axle, which consists partly of a Maher and Platt "Manchester" dynamo, set up on end. The whole is supported by a strong cast-iron frame, and is bolted to masonry. A carbon block rheostat, by Rousseau, of Finsbury, is in circuit with the armature, and enables the speed to be regulated by varying the current supplied by a storage battery. The speed so far obtained is about 1,500 revolutions a minute, and the light has been passed several times round, each way, in the space between the discs. A pulley on the axle serves for a brake, and a syren disc above enables the speed to be quickly estimated. So far as experiments have yet gone, it may be asserted that the velocity of light is not affected in the neighborhood of moving matter by so much as one-thirteenth of the velocity of the matter. But this result is quite preliminary, and it will be some time before the investigation is concluded.

Prof. Horace Lamb and several members expressed some interest in the apparatus, and in the question to be settled by it. Dr. Johnstone Stoney doubted whether the discs could hope to move the ether much, when the much larger mass of the earth itself might be effective in keeping it still; and Prof. Osborne Reynolds warned the experimenter of the danger arising from the rapidly whirling steel discs, pointing out that though to simple traction a tenacity of 67 tons per square inch might be attained, yet the conditions of surface strain in both directions to which the discs were subjected were very different, and not much was known about them. In this connection it may be interesting to remark how enormous centrifugal force may be compared with any intensity of gravity met with anywhere in the solar system. For instance, if a pound mass were put into a hollow drum, one foot in radius, spinning 100 times a second, it would fly up against the side, and press on it with a force of four tons weight. No wonder that cream is rapidly produced in milk-whirlers, which are often driven much faster than this.

Dr. J. Larmor next gave a general account of some mathematical investigation of the theory of electric radiation, starting from a Hertz vibrator as source. He did not say very much about his methods or results, but he found that reflecting surfaces behaved very differently to waves of great and waves of small length. Waves of great length, say much longer than a centimetre, are reflected by all conductors about equally well, without regard to small differences in their conductivity, without much regard to the substance, that is. But very short waves, say much shorter than a centimetre, experience an effect due to the conductivity of the reflecting substance; and accordingly waves of light, so small as to be visible, feel every difference in the state of polish of a surface, as well as in the material of which it is made.

Prof. D. E. Jones, of Aberystwith, described some experiments he had been recently making in Prof. Hertz's laboratory at Bonn, with the object of observing the rate of propagation and the rate of damping out of waves along wires. He does it by inserting a thermo-couple in the course of the wire, so that electric oscillation set up in the wire shall surge through it and heat it perceptibly. If the couple is placed at a node, however, no heating effect should be experienced. In the middle of a vibrating segment, the heating effect should be a maximum. Prof. Jones finds no absolute nodes or places of no electric current in a finite wire of considerable length, along which short Hertz waves are traveling and being reflected; but he finds places of minimum heat. The damping out of the waves prevents the interference of direct and reflected waves from being complete; there is a certain proportion of stationary waves, and a certain proportion of progressive waves, the latter disturbing the thermopile equally, whatever its position. One of the most interesting things observed was that if the receiving plates attached to the wire were placed very near to the vibrator, then scarcely any waves were excited: the energy of the vibrator seemed to be consumed by the receiver, the two probably oscillating together in opposite phases, and leaving very little disturbance to be propagated to a distance. Or it may be expressed by saying (as Mr. Blakesley suggested the other day at the Physical Society) that the virtual self-induction of the emitter was so much reduced by the mutual induction of the receiver that no sufficient inertia was left, and the oscillations were almost killed—the discharge being made dead-beat. It is a question whether the thermopile and galvanometer can be a very good plan of detecting nodes and ventral segments along wires; and it is surprising that it is sufficiently sensitive to show them. The fact that it is so, and that loops of thin iron, such as lead to the galvanometer, do not seem to disturb the position of the nodes, is interesting.

Next a paper was read from Mr. W. Thorp, relating some experiments he had made in Prof. Fitzgerald's laboratory, on the propagation of Hertz waves along very thick and very thin wires. Elementary theory indicates that the velocity of pulses along thin wires should be the same as in air, and along thick ones a trifle slower. But Mr. Thorp finds that the velocity (as indicated by wave length) is greater along brass gas-pipe of about an inch diameter than it is along copper wire less than the tenth of a millimetre thick. If this observation is confirmed it will want serious consideration. Many observers measured the rate of travel along wires, and found it practically equal to the velocity of light, but they have not examined thicknesses so different as those Mr. Thorp uses. It remains to be found whether the resistance of excessively thin wires is able to retard the pulses and cause them to travel much more slowly than they otherwise would. At present Mr. Thorp's observation is a most interesting possibility, which needs confirmation and development.

An important paper from Lord Rayleigh concluded the work of this day. It was purely optical, and relates to the amount of light reflected at the polarizing angle from clear liquids.

*Abstract from *The Electrician* (London).

On Saturday the section found it unfortunately necessary to divide, and to sit half of it for pure mathematics and the other half for electrolysis and physical chemistry. A very valuable table involving an immense amount of compilation work was handed in by the Rev. T. C. Fitzpatrick, of Christ College, Cambridge, as part of the report of the Committee on Electrolysis. It endeavors to summarize and tabulate all that is known concerning the conductivity of solutions of the various salts at different strengths. It will, no doubt, be printed in the annual volume, and be long useful as a work of reference.

Mr. J. Brown criticised the recent writings of Prof. Ostwald and the arguments adduced by him in support of the dissociation theory of electrolysis, pointing out that many of them were equally reconcilable with the simple Grotthus chain theory. In particular, he criticised an experiment which excited a good deal of interest at Leeds last year, viz., where copper nodules make their appearance on the face of a partition of ferrocyanide of copper interposed in the path of the current, as if they were filtered out by a "semi-permeable membrane," and left behind. Mr. Brown has examined this substance, the ferrocyanide of copper, and found it slightly metallically conducting. Now directly a conducting partition is interposed in the path of a current in metallic salt solution, nothing is more natural than to get a metallic deposit from it. Hence, he concludes that the experiment of Ostwald has no bearing whatever in favor of one theory rather than another; that it is in fact of no particular interest. Mr. Preece said that the nodules of copper found on the porous cells of Daniell batteries were due to specks of conducting matter in the clay, and that by more carefully selecting the cells no such deposits were obtained. Unless something fresh can be adduced by Prof. Ostwald, there seems, therefore, to be no further mystery or interest in this dropping out of ions from the path of a current, a phenomenon which might have had considerable theoretical import, and which, apart form this conductivity explanation, was very puzzling.

Mr. Chattock gave an account of an elaborate series of measurements which for two years or more he has been making on the discharge of electricity from points. Many very interesting facts are being brought to light by this research; he has elaborated a method of measuring the atomic charge in gases, and has shown that it is something comparable to the known charge on atoms in electrolysis. His investigations also go to confirm the theory of Prof. J. J. Thomson with reference to molecular chains—a string of short Grotthus chains—which, by breaking down, bring about the electric discharge observed. All this work of J. J. Thomson in vacuum tubes, and of Chattock on ordinary and rarefied air near points, is closely related to the phenomena of electrolytic conduction in liquids, and before long the three sets of facts will certainly throw considerable light upon each other.

Mr. Clayden exhibited a number of beautiful meteorological photographs, taken by observers in different parts of the world; photographs of clouds, of lightning, of hoar frost, and of many other meteorological and interesting evanescent effects. The photographs of lightning are especially valuable, and the ribbon appearance so often seen is found to be produced even when the camera is quite fixed. True multiple effects likewise, however, occur, and these have been imitated, to some extent, by Mr. Clayden by photographing simple Leyden jar sparks in the circuit of which greater or less resistance is interposed. Prof. Ogden N. Rood used to observe the direction of lightning by watching a cardboard disc, with radial spokes drawn on it, twirled on a shawl pin during a thunder storm on a dark night. Some flashes are instantaneous, others are multiple or intermittent. Doubtless the noisiest and most dangerous are the sudden ones. It is to be hoped that many observers will combine to swell the collection of lightning photographs being made by the committee, of which Mr. Clayden is secretary, and Mr. J. G. Symons chairman; and, if taken with due regard to the instructions which the committee will issue, they cannot help adding largely to our information concerning atmospheric discharges.

On Tuesday, after a report from the Committee on Electrical Standards with reference to the minute changes going on among the wire and mercury standards of resistance, Mr. Swinburne gave a summary of a long and detailed piece of work on the causes of variation of Clark cells, which it was very difficult to follow ordinarily, but which will doubtless be very useful to experimenters interested in the practical construction of standards of E. M. F.

A discussion on electrical units was then commenced. The writer spoke on the naming of a coefficient of induction, and of a unit of magnetic induction, both of which he believes to be needed in practice. If the secohm is to do for the one, the secvolt will do for the other; and the unit of field intensity would be a secvolt per square centimetre. He believes that a unit of magnetic induction or total number of lines of force passing through an armature coil is more immediately applicable to practical use than is the idea of a certain length of wire moving across a field with a specified velocity, as advocated by Prof. Perry. An induction of one secvolt passing through a coil is such that if the coil be rotated so as to cut out all these lines in one second, the average E. M. F. set up in every turn of it is one volt. It may also be expressed as a secohm $\times$ ampère. The secohm, or quadrant, or whatever it is to be called, is an inconveniently large unit, but *perhaps* it is better to adhere to the systematic arrangement, and not introduce any fresh multipliers, not even one-thousandth. It is for practical men themselves to decide this question, and the particular names to be employed for these units is also a matter of taste. Mr. Preece was expected to continue his advocacy of enlarging the present volt and ampère each 10-fold, and the present watt 100-fold, a procedure for which there is much to be said. Likewise, for altering the name of the microfarad to a farad, so that sub-multiples of it may conveniently be named, the farad itself being absurdly too big —greater than the capacity of the solar system. He did not, however, bring forward anything very revolutionary. Prof. W. Stroud, of Leeds, strongly advocated the change from present volt to one ten times as big, and from present ampère to the simple C. G. S. unit, which is likewise ten times as big; and pointed out that this simple change would get rid of all the present no-system of having to use 10, 10^7, 10^8, 10^9, and the reciprocal of these quantities as factors to count for C. G. S. units; and would make all the practical units be derived straight from the C. G. S. unit by multiplying either by 10^9 or by unity. It is a great pity that this 10^9 system was not adopted at first, but the meeting was evidently averse to any sort of change being introduced now. The tables drawn up by Prof. Stroud, showing the advantage of the changes advocated by him, were very thoughtful and well considered. Dr. Johnstone Stoney, who had had so much to say at the birth of the C. G. S. system, and who stood out for a more immediately metric system, because he saw that the dyne and erg would be too grotesquely small for engineers, said that however much he regretted the adoption of the centimetre, it was too late now to alter it, and he proposed adhering to present units with a simple method of naming multiples or sub-multiples of them by any power of ten or one-tenth, which he had previously advocated, and which is frequently already used for wave lengths.

A number of speakers followed, each pursuing his own line of thought, and the closing hour decided on by the sectional committee arrived before anything like agreement could be come to on any one point and long before the discussion was half over. The extra subject of mechanical units (moments of inertia and the like) remained perforce untouched. Some remarks were made deprecating the idea that resistance was really a velocity or capacity, or self-induction a length; and the need for retaining one of the unknown quantities k or μ as a factor until further knowledge tells us its dimension and numerical value was, as usual, insisted on.

At the university college adjacent to the section Prof. J. V. Jones exhibited in action his beautiful form of Loveni's method of determining the ohm. By means of a rotating disc inside a coil he determines the absolute specific resistance of mercury direct, aiming at an accuracy of one part in 10,000. He speaks of issuing absolute standards of very low resistance, say one-thousandth of an ohm, etc., provided with tapping terminals as well as main terminals, so that an electrometer applied to them may be used for measuring very powerful currents.

Mr. Trouton described some curious and purely magnetic observations he had made on large iron rings submitted to a magnetizing helix conveying an alternating current, and having another helix connected with a telephone arranged as feeler, and moved about over the ring. He thus found, to his surprise, nodes or places of telephonic silence, as if the magnetic pulses took time to travel, and formed a system of stationary waves with nodes and ventral segments at regular intervals round the ring. Dr. Larmor suggested that the ring might be thrown into mechanical or Jouleian vibrations by the alternating current, and that the telephone coils might be affected by these slight motions, so as to give equal opposite effects on opposite sides of certain regions or nodes. The nodes could hardly be real magnetic interferences, because a galvanometer failed to show them. A telephone was essential.

The remaining five papers had, for want of time, to be taken as read. Thus ended a meeting which, though, perhaps, nothing specially brilliant or sensational can be asserted of it, maintained its usually high scientific level, and was representative of the immense amount of first-class work which is at the present time being accomplished in physical science.

Business of Parent Companies.

"Rumored Changes in the Edison Company" was the subject of a note in THE ELECTRICAL WORLD of Sept. 12 that has caused considerable comment. The head of a supply house that has become famous under his shrewd and careful management, when asked in reference to the matter, while lunching at the Chicago Electric Club, said:

"I know but little about the managers of the Edison company, but have always heard of them as being men of good ability, and from the resolutions passed at the last annual meeting it would seem as if the business were carried on to the apparent satisfaction of the stockholders. I notice that the Edison company has been gradually giving more attention to the sale of supplies and less to the installation of central stations by themselves. It seems to be a generally well established fact that two different classes of business, widely different in nature, cannot both reach the highest success under the same management, as while the organization may be suited to one form of business, it will be either too elaborate or not extensive enough for the other. I suppose when the policy was adopted by the Edison company of giving more attention to the sale of supplies, it necessarily followed that the company would give less attention to the installation of Edison lighting plants. If it is true that there is to be any change in management on account of dissatisfaction (which seems hardly probable), it might be that the company has decided to change back to the old policy. I have not had wide experience in the possible profits in electric lighting, but I have had considerable experience in the supply business, which is no better in profits and gives no greater promise for the future than a great many other lines of mercantile business that must be carefully watched if made to pay at all, and then cannot be expected to produce more than a fair average profit. There are some things connected with the supply business, such as newness, lack of system and stability, and the inexperience of a great many attempting it, that make it less satisfactory than most of the older lines of trade. It would hardly seem as if capital invested in the supply business could compare with investments in central station incandescent lighting, either in present profits or future prospects. I am informed that after paying interest and a sufficient per cent. for depreciation, a well managed incandescent plant fairly well located can be made to pay from 10 to 20 per cent. profit. If this is true, I think that a large parent company with a sufficiently large capital could better afford to install central stations with the intention of owning them rather than of attempting to sell them out. This done systematically would have a great many advantages. The plants would be entirely under the control of the parent company, and the additions to the plant and all of the supplies could be sold at a good profit and with a very slight expense. If guaranteed by the parent company, bonds could be issued, bearing five per cent. interest, which could be more readily sold than bonds of local companies bearing a larger rate. The dividend from the local companies should in itself yield a handsome profit. The capital stock of the companies could be made considerably more than the actual cost of the plants or the amounts which would leave a fair per cent. on the probable profits. In the end, if it was desired, all or part of the stock could be disposed of at a price which would yield a handsome profit, as all investors are willing to pay considerably more for an enterprise that is an assured success than for one that is only starting, and is a venture.

"It seems to me that the great advantage of such a business, when extensively and systematically carried on, lies in the great probabilities of success in each individual case and the small chance of failure. If the lighting companies do not pay, it is sometimes due to competition or other local conditions (not so often as formerly), but generally it is due to poor management, and a large parent company owning a great many sub-companies could have superior means of watching them and comparing one with the other, and by studying the monthly statements of each the results of poor management would be apparent and changes could be made before much time had been lost. Most forms of business will not pay until they are made to, and if some lighting companies were able to make good profits, all could be made to pay.

"One important thing to remember is that incandescent lighting is rapidly growing and will show even a more rapid growth in the future. People are gradually coming to more thoroughly appreciate its advantages, which leads to its being more universally adopted, and at the same time they are becoming more satisfied to pay a higher price, realizing that they should not expect something so superior as electric light is over gas to be furnished at the same price, any more than they would expect gas to be furnished at the price of oil. The growth of incandescent lighting will probably make it possible to place large and well paying incandescent plants in towns that to-day can support only very small ones.

"We are all endeavoring to discover a business that will give us the greatest amount of profit with the least amount of expenditure and with the least risk, and I would like unusually well to have a business which would seem to so fully satisfy these conditions and give the splendid promise for the future as central station incandescent lighting."

The Edison Pressure Indicator.

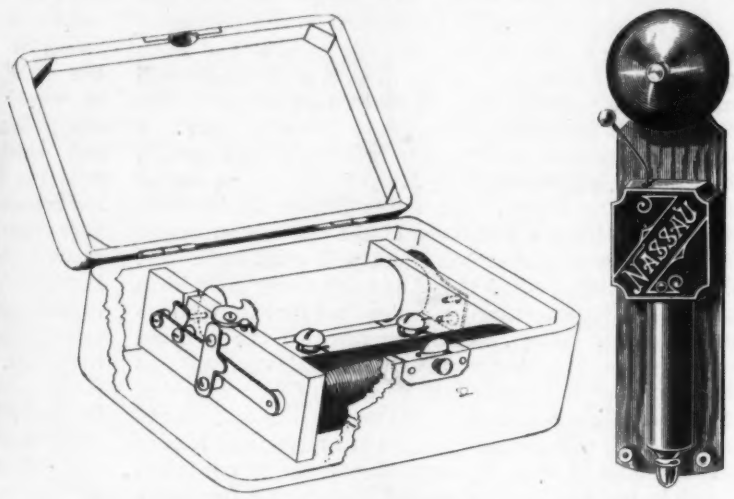
Electrical development has been so rapid in the last few years that the number of instruments and electrical appliances brought out can be numbered only by the thousands. The industry, however, is subject to such rapid changes that few of the instruments and appliances known a few years ago have stood the test of time so as to be of service to-day. Consequently any instrument that has lived through the early years of experiment and severe tests, and still remain standard, must be considered of especial interest. Of such a character is the Edison pressure indicator, an instrument that has a very interesting history.

In 1884 engine room indicators were commercially made and used, in which changes in resistance of carbon filaments caused by variations in the pressure were made to measure and indicate those changes. During the seven years which have since elapsed, various forms of indicators have been made, tested and tried, but none has been found to equal the carbon resistance indicator in accuracy, convenience and permanence, in ability to stand a long, rough journey

and be in perfect order at its end; in the ease with which any one who will read the directions can set the instrument up and get accurate results from it, and, above all, in regard to the large movement of the pointer produced by a small change of pressure, the arrangement of scale and pointer which enables the attendant to see small movements of the pointer at a distance, and the fact that the instrument contains means whereby its readings may be checked at any time, each instrument being in fact two indicators, one of which is always held in reserve to be used occasionally in calibrating the working indicator and correcting any change which may have taken place in it.

The Edison indicator, as it stands to-day, is the result of seven years' experience and experiments with all kinds of indicators, including various forms of carbon resistance indicators; and for the work for which it is intended it is

THE EDISON PRESSURE INDICATOR.



NASSAU MEDICAL BATTERY. NASSAU BELL.

claimed to be practically a perfect instrument. It is an engine room indicator and a very efficient guide to the engineer or attendant in charge of dynamos.

The proper operation of an incandescent electric light plant demands good regulation, the pressure must be uniform and must be right or the plant will not give the best results. Uniformity in the pressure is very necessary. Lamps operated on a circuit, the pressure of which is sometimes above and sometimes below normal, never give satisfaction, while lamps operated on a circuit with uniform pressure are more satisfactory, and give a better light and life, even though the pressure averages several volts higher than the normal.

A uniform incandescent light causes no comment. It simply does its work, and as it never attracts attention it is not subject to adverse criticism.

Good results demand not only uniform pressure, but correct pressure. Dim lamps can never be satisfactory; neither will lamps operated at a high pressure, as they deteriorate and break. This is especially true regarding high efficiency lamps, so that to secure good results the resistance of a good, reliable and convenient indicator is an absolute necessity.

Nassau Pocket Medical Battery.

This battery is designed to provide what has long been desired, viz., a medical battery sufficiently small for pocket use, but at the same time possessing the necessary strength and the other advantages of the large and expensive office batteries. Its general appearance is well shown in the accompanying illustration. It is operated by the well known Nassau Capsule Battery, which has a dry, close sealed cell, requiring no handling of the tension and involving no manipulation of sulphate of mercury or bichromate of potash or other chemicals and always ready for use. The induction coil is constructed in such a way as to give good results and is claimed to give a higher efficiency than has heretofore been obtained with coils of the same size. It is provided with a very accurate and convenient appliance for regulating the strength, this being done by merely turning a small screw, which projects at the end of the case.

A Compact Door Bell.

The accompanying illustration shows a very compact outfit intended for door bell use. It stands on a hard wood frame, to which are attached an electric bell and Nassau capsule battery, held by contact springs and protected by removable guard and binding posts, all connected and ready to be placed in position. In addition to this, the outfit includes a push button, staples and 75 feet of insulated wire. The outfit is supplied in various styles to suit the different varieties of decoration in places where it is used. The batteries may be replaced when once exhausted with very little difficulty. The apparatus is placed upon the market by the Nassau Electrical Company, of New York City.

Edison Mining Drill.

One of the most prominent exhibits at the Electrical Exhibition held in connection with the Montreal Conventio..

THE EDISON MINING DRILL.

The result of the whole experience of the Edison company is that the pressure indicator, shown in the accompanying illustration, is by far the best that has ever been produced by the company.

was that of the Edison General Electric Company. A portion of this exhibit was illustrated in the last issue of THE ELECTRICAL WORLD. A feature of the exhibit, however, not shown in our illustration, and one which attracted as much attention as any part of the whole exhibit, was that of the Edison percussion and rotary mining drills. The accompanying illustration shows these two machines at work in a Colorado mine. The Edison percussion drill will bore at the rate of three inches per minute in the hardest granite. It requires but little power to operate it and, of course, can be worked at any reasonable distance from the dynamo, the limit suggested by the company being three miles. The drill is simple in construction and there is nothing about it that would be affected by moisture. The Diamond prospecting core drill, designed for locating mineral deposits, was also shown. This machine will bore 150 feet into the earth, bringing out specimens of mineral for the examination of the prospecting parties. Aside from this, the exhibit at Montreal included coal drills, electric hoists, fans and pumps for mining use, an indication that the Edison company is turning its attention in a very practical way to this very important application of electricity.

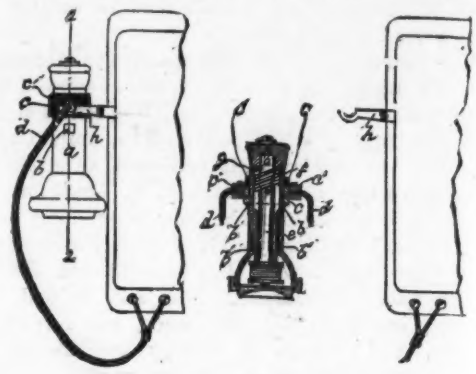


FIG. 1.—HOWARD'S TELEPHONES.

Howard's Improved Telephones and Magneto Bells.

The accompanying illustrations show some new forms of telephone devices recently brought out by Mr. Jas. H. Howard, of the Tropical American Telephone Company.

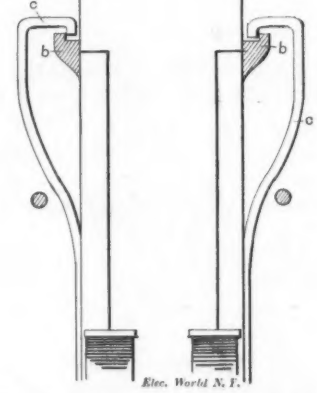


FIG. 2.—HOWARD'S TELEPHONES.

Figs. 1 and 2 show an improved receiver which embodies in its own construction a switch device to cut out the coil circuit in the telephone itself when the phone is not in use. Two nails driven in the wall between and on which to hang the phone are sufficient with this apparatus to cut out the phone, and two point switch costing not over half a dollar would cut in the ringer circuit of any call bell, or this can be done by a simple circuit closer on the phone called into action when the phone is hung up.

Another of these inventions, Fig. 3, is intended to provide a cheap and simple way of supporting the telephone when not in use and at the same time operate a switch device for cut-

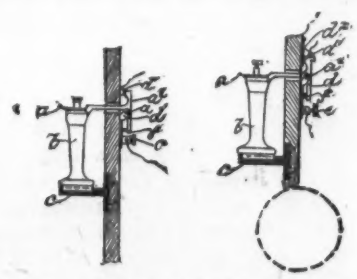


FIG. 3.—HOWARD'S TELEPHONES.

ting out and in the telephone circuit. It could also be made to cut out and in the ringer or generator circuit.

Another device, Fig. 4, is intended to provide an improved call bell with a self-acting shaft to rotate the armature so that one or any number of signals can be given with ease and certainty, where several stations on one line require a different number of rings or calls for each. It also does away with electrical connection with the ringer through the door hinges, and leaves the door free so that no hinges are required, three or four wood screws replacing them, besides providing a convenient place for a directory of those subscribers most used. For this purpose a card is slipped into the rack on the door. The movable jaws supply support for the telephone when not in use and also operate a

switch device and circuit cut-out. The lightning arrester is a simple two point switch on the side of the call bell where it can be readily seen and operated.

The improved apparatus will be controlled exclusively by the Tropical American Telephone Company, and will be introduced first into foreign territory and later into the United States to supply the private line business.

A Small Electric Light Outfit.

The accompanying illustration shows the complete electric light plant, connected and ready for operation, as

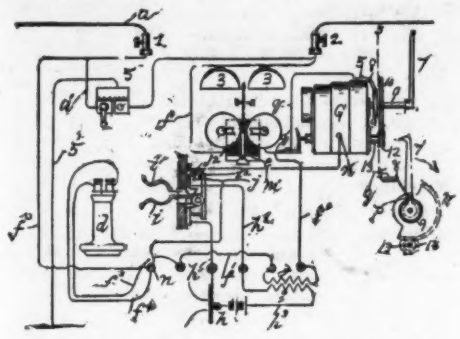


FIG. 4.—HOWARD'S TELEPHONES.

manufactured and placed on the market by Forée Bain, of Chicago. The apparatus shown has been designed for practical every day use, and has been simplified as far as possible by leaving off all unnecessary features, and it is claimed that the combination here shown is as thoroughly practical and reliable as any of the larger electric light plants, and that the generators as rated will maintain the full number of sixteen candle power lamps, without being overloaded. The voltage and speed are plainly stamped on each machine, each generator is fully tested at full load before it leaves the factory, and any duplicate part of the whole apparatus can be furnished by the company.

These plants are made of various capacities, running from 5 to 50 sixteen c. p. lights.

A Typical Roof for Central Stations.

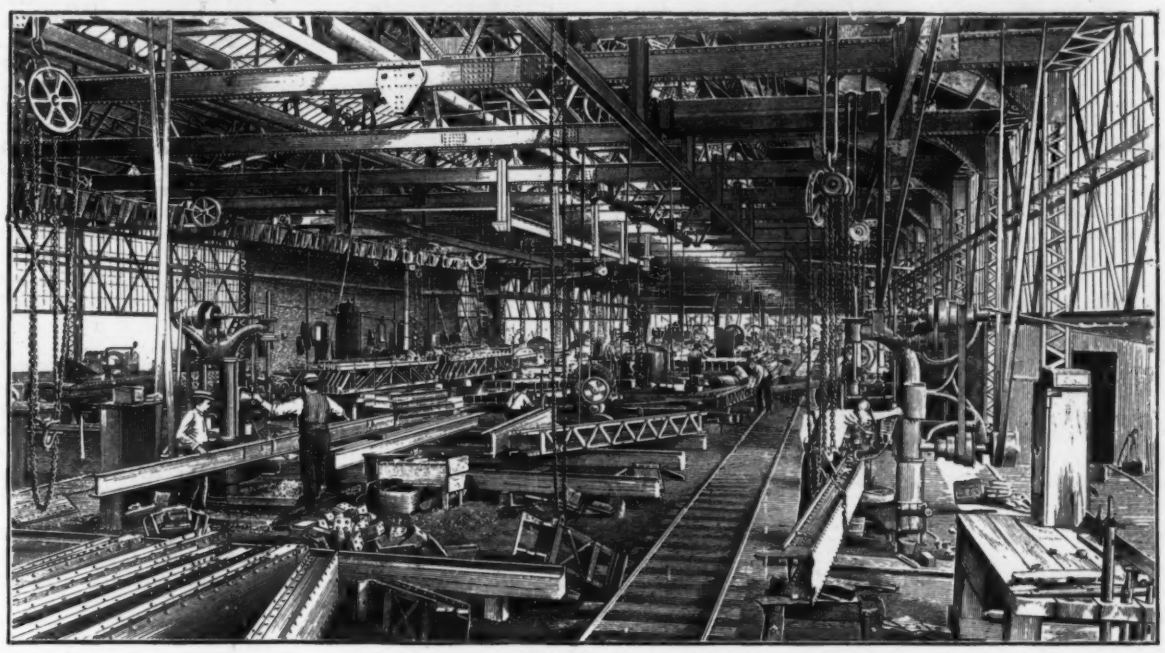
No company in this country has probably had as large experience in the designing and construction of manufacturing plants as the Berlin Iron Bridge Company, of East Berlin, Conn., and therefore we present to our readers in this issue an illustration showing the character of the plant which the company has recently built at East Berlin, Conn., for its own work, which is one of the best designed and equipped for all kinds of structural iron work of any plant to be found in this country.

FOREE BAIN'S LIGHTING PLANT.

The main building is 400 feet long by 80 feet wide, constructed entirely of brick, iron and glass. The general features of the construction are shown in the interior view. The sides of the building are made of glass for a distance of 10 feet from the eaves and below that are constructed of iron sliding doors so arranged that they can be opened and closed quickly in order to allow the material to enter through the sides of the building, when necessary, and in summer they can be removed entirely, thus very materially adding to the comfort of the employés.

The roof trusses are of iron, each truss designed to carry 10,000 pounds at any point along the line of the lower chord. The whole plant is connected together by standard gauge tracks in such a way as to admit of the economical loading of the finished product.

The standard gauge tracks extend the whole length of the plant. On each side and at the front of the building from which the finished product is discharged there are other spur tracks of standard gauge, one of which enters the building for a distance of 120 feet, so as to admit of iron being loaded inside of the building during wet weather.



BERLIN IRON BRIDGE COMPANY'S ROOF CONSTRUCTION.

All the tracks are controlled at the front of the building by two jib cranes, so arranged as to work from a four-drum Mundy hoisting engine, so that one man can operate both cranes at one time. The loading facilities are of such a nature that ten cars can be loaded in an ordinary day of ten hours.

The plant is lighted by a Thomson-Houston dynamo, with 250 incandescent lamps and 12 arc lamps all on the same circuit, the arc lamps being used to light the yard and give general light for the shops, with two incandescent lights at each machine.

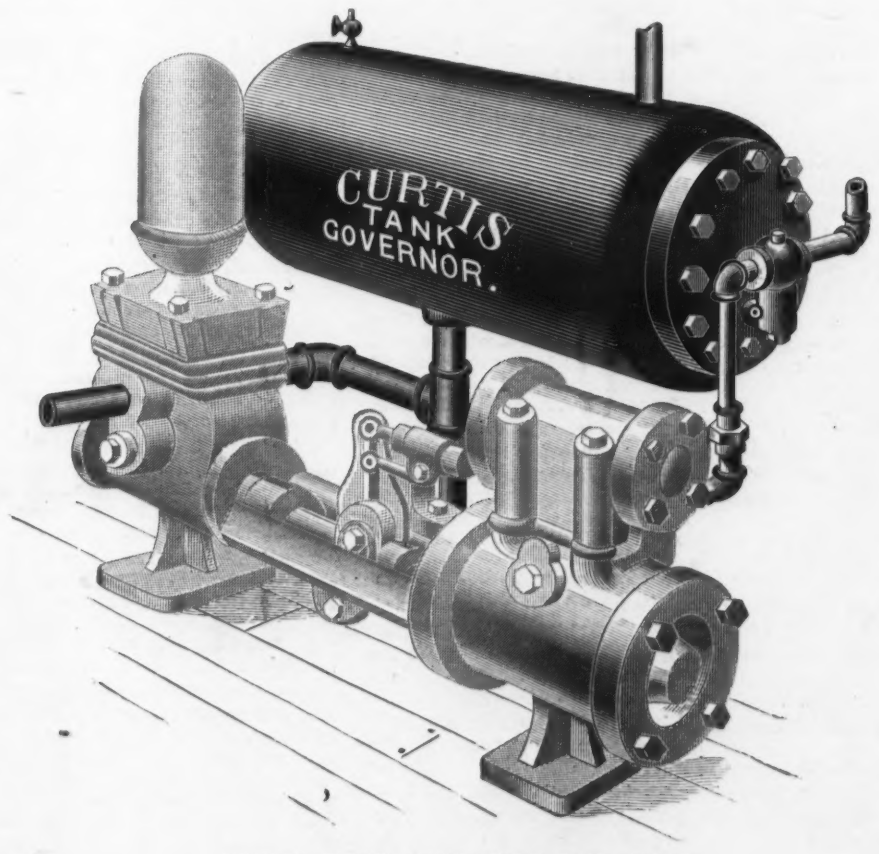
The construction being of iron the cost of maintenance consists only of painting, so that here we have a plant which seems to combine all the requisites of improved shop practice, as certainly with the improved facilities a shop of this kind ought to handle all classes of structural work with the least possible outlay of labor.

In a construction of this kind certainly the cost of maintenance, repairs, insurance, and that class of expense is reduced to an absolute minimum.

The Curtis Combined Tank Governor and Pump.

This apparatus forms a very compact and effective combination of receiver and boiler feed pump, all piped together and ready for service, by means of which the returns from any system of heating or drying in which steam is condensed are automatically and regularly brought back into the boiler against any pressure that may exist, and at the highest possible temperature. This applies to steam coils, radiators, steam jackets, etc. In addition to a steam pump of the best make the apparatus includes a closed tank into which the returns are brought by gravity.

To the removable head of the tank is attached a frictionless, balanced steam valve, operated by a hollow float and lever on the inside. This float is so arranged in connection with the valve that it maintains a constant water line in the tank, speeding or retarding the pump in exact relation to the quantity of water entering it from the returns, so that there can be no accumulation of water in the tank, and as it is always partly full of steam the water from it enters the boiler at the full temperature of the steam with which it is in contact, and with a steady continuous flow as fast as it enters the tank. The steam pipe on the tank is piped to the pump, and the suction of the pump is piped to the bottom of the tank into which it projects upward a short distance thus forming about it (in the bottom of the tank) a trap to catch all dirt or scale which would otherwise pass into the pump.



CURTIS TANK GOVERNOR AND PUMP.

The pump and tank are piped together for use, and need only to be connected to the boiler and the return pipe from the circulation. The apparatus is placed upon the market by the Curtis Regulator Company, of Boston.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

TELEPHONE STOCKS.

Chicago	$230@	$235	Cumberland	$60@	$62
Central Union	52@	53	Wisconsin	118@	120
Michigan	83@	84	Bell of Missouri	175@	180
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri and Kansas	54@	56
Rocky Mountain Bell.	40@	43			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$97@	$99	Chicago Edison Co. $145@$155

NEW INCORPORATIONS.

The Pratt Electric Belt and Supply Company, of Chicago, has been incorporated with a capital stock of $200,000. The incorporators are Aaron K. Stiles, W. W. McDonald and H. P. Pratt.

The Gray Electric Company has been organized at Chicago to manufacture electrical apparatus. The capital stock is $100,000. The incorporators are Elisha Gray, F. W. Cushing and Leon O. McPherson.

The Harvard Electric Light and Power Company, of Harvard, Ill., has just been incorporated, with a capital stock of $15,000. The company will furnish heat, light and power. The promotors are James E. Keelyn, E. L. Church and A. W. Young.

The Goshen Light and Power Company has been formed at Goshen, N. Y., with a capital stock of $15,000, for the manufacture and use of electricity for light, heat and power. The organizers are J. W. Corwin, William H. Wyker and Robert B. Hick, all of Goshen, N. Y.

The Washington Illuminating Company, of Washington, Ia., has been incorporated with a capital stock of $50,000, and will furnish both gas and electric light to the city of Washington, Ia. The promoters are Norman Everson, E. E. Everson and D. W. Hunt, of Washington, Ia.

The People's Gas and Electric Company, of Chillicothe, Mo., with a capital stock of $50,000, has been formed to locate, purchase, construct and maintain gas and electric works in the city of Chillicothe. C. D. Jones and S. B. Hovey, both of Independence, are interested in this company.

The Electric Construction Company, of Roanoke, Va., has been organized with a capital stock of $300,000 to prosecute the business of electric railway construction and supplies. The incorporators are H. W. Sellers, S. E. Hass, C. A. Pearson, A. C. Deniston and R. J. Byron, of Philadelphia, Pa.

The Waterloo Electric Light and Power Company, of East St. Louis, Ill., with a capital stock of $10,000, has been incorporated to build and maintain an electric light and power plant and water-works in Waterloo, Ill. William Wurdack, M. A. Waters and R. M. Hammon are the incorporators.

The Kensington Street Railway Company has been formed, with a capital stock of $12,000, and will operate a street railway in the borough of Kensington, Allegheny county, Pa. The promotors are John S. Alles, S. Stafford, A. E. Alles, Henry Alles, Sr.; Jacob Alles, all of Pittsburgh, Pa.

The Madisonville Electric Light, Heat and Power Company has been incorporated at Madisonville, O., with a capital stock of $30,000, for furnishing electric light, heat and power. The organizers are John G. Luhn, Edwin S. Emerson, Jno. S. Nowotny, F. R. Lindsay and J. G. Rawn.

The Oswego Electrical Company has been organized at Oswego, Kan., with a capital stock of $50,000, to supply light and heat by electricity, through and by electrical appliances. Its incorporators are A. D. Carpenter, B. F. Henderson, F. G. Van Sant, all of Oswego, Kan., and M. V. Barnum, Chicago, Ill.

The Portsmouth Electric and Power Company has been formed with a capital stock of $10,000, for constructing and operating a street railway and furnishing electrical power in the city of Portsmouth, O. The promoters are Anselm T. Holcomb, Geo. Dabis, F. J. McGinnis, Floyd L. Smith and Samuel B. Timmonds.

The Peninsular Electric Light and Power Company, of Newport News, Va., with its principal office at Newport News, Va., has been incorporated, with a capital stock of $100,000, to furnish electric light and power. E. C. Hillyer, L. P. Stearnes, G. A. Schmelz, W. W. Archibald and T. H. Gordon are the incorporators.

The Randall Street and Electric Car Manufacturing Company, of Kittery, Me., with a capital stock of $50,000, has been incorporated to prosecute the business of manufacturing and dealing in street and electric railway cars. Isaac H. Randall, of Boston, Mass., and William F. Miller, of Chestnut Hill, Mass., are the organizers.

The Pittsburgh Underground Electric Construction Company has been incorporated at Pittsburgh, Pa., with a capital stock of $300,000, for the purpose of manufacturing, constructing and erecting electric traction roads, laying tracks and roadbeds, etc. The incorporators are Chas. D. Robbins, D. J. Rex and J. J. Miller, all of Pittsburgh, Pa.

The Nicholson Electric Hoist Company has been organized, with a capital stock of $30,000, for constructing, operating and selling machines for hoisting and conveying purposes, etc. The principal place of business will be at Cleveland, O. The promoters are D. A. Dangler, Martyn Bonnell, E. C. Pope, H. D. Coffinberry, H. P. Lillibridge and Ezra Nicholson.

AFFAIRS OF THE COMPANIES.

The Edison General Electric Company has declared the eighth quarterly dividend of 2 per cent. on all the stock of the company, payable Nov. 2.

The Edison Electric Illuminating Company, of Boston, has declared a semi-annual dividend of three per cent., payable Oct. 1 to stockholders of record Sept. 23.

Thomson-Houston Dividend.—"Rialto," in the Boston *Advertiser*, says the talk is that the next dividend on series D of the Thomson-Houston Company stock will be $1 per share.

The Thomson-Houston Electric Company's stock has been placed upon the regular list of the Boston Stock Exchange by the governing committee. This includes both preferred and common stock of this company.

Westinghouse Affairs.—One who has very close relations with the Westinghouse Electric Company is reported as saying: "The company is now employing 1,300 men in its factory, and as the business is increasing it will soon have to increase its force of employés. The company is doing business at about the rate of $3,000,000 per annum. This is its regular business, not business obtained at an expense of agencies, etc. I think the company is surely doing business at as much profit as the Thomson-Houston company, which claims 30 per cent. profit. At this rate the company would earn $900,000 per year or nine per cent. on its capital stock. The syndicate which promised to take the $3,000,000 new preferred stock has signed the agreement but has not yet paid the money as the new certificates, which are being printed, have not yet been issued."

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Sept. 28, 1891.

Mr. A. L. Daniels, of the Mitchell-Brant Copper Company, of Erie, Pa., was in the city this week looking after the business of his company, which is the manufacture of commutator segments and copper castings of all kinds. Mr. Daniels is well known to the trade as the former representative of the Eureka Tempered Copper Company and is of course meeting with success.

Removal.—The New York offices of the Brush Electric Company, of Cleveland, will be removed from 36 Union Square to the Boreel Building, 115 Broadway, on Oct. 1, and to this address all communications should be sent. Mr. Samuel H. Hamill, secretary of the company, has been in charge of the eastern office for the past three years, but has now removed to Cleveland to assume the duties of general manager, in place of Mr. Chas. S. Pease, who has recently resigned. Mr. Hamill is, however, still in charge of the eastern offices. These offices have been located at Union Square for a number of years. The original offices, which were on the northeast corner of the square, were subsequently removed to the Domestic Building and later to 39 Union Square, where they have been located for several years.

The American Institute of Electrical Engineers.—The following Associate members were elected at the Council meeting, Sept. 22, 1891: Fordyce S. Caldwell, proprietor Western Electric Construction Company, Kansas City, Mo.; Frederick G. Cartwright, electrical engineer, and agent Fort Wayne Electric Company, San Francisco, Cal.; W. C. Cheney, electrical engineer, Willamette Falls Electric Company, Portland, Oregon; Charles W. Foote, agent railway department Thomson-Houston Electric Company, Cleveland, O.; John L. Hall, manager Western Union Telegraph Company, Wilmington, Del.; William H. Hamilton, dealer in electrical supplies, Albany, N. Y.; Henry H. Hosford, electrical engineer, Cleveland, O.; Frank Land, Syracuse, N. Y.; Robert Heath MacMullan, treasurer and general manager Brush Electric Lighting Company, Lafayette, Ind.; Lucius E. Marple, electrician, United Electric Railway, Nashville, Tenn.; Wm. Morris Mordey, electrician, Brush Electrical Engineering Company, London, Eng.; Everett Morss, electrician, Simplex Electrical Company, Boston, Mass.; Frank A. Pattison, firm of Pattison Bros., consulting and constructing electrical engineers, New York City; Edward H. Rogers, patent lawyer, firm of Pope and Rogers, New York City; W. M. Rutherford, electrical engineer, Thomson-Houston International Electric Company, Boston, Mass.; Fred. G. Schlosser, superintendent of Electrical Department Laclede Gas Light Company, St. Louis, Mo.; Geo. Montagu White, agent for West Indies, Thomson-Houston International Electric Company, Kingston, Jamaica, W. I.

L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Sept. 26, 1891.

Dover and Foxcroft, N. H.—A contract for electric lighting for these places has just been closed.

Manchester, N. H., is asking for bids for electric lighting. Two hundred and fifty arc lights will be required.

Mr. Fred. H. Angell, representing the Electrical Specialty Company, of Pawtucket, R. I., was in town last week.

The Naumkeag Street Railway Company has renewed its petition for permission to equip its road with the trolley system.

Mr. S. A. Barton has purchased the wire works of B. S. Hale & Son, of Malden, in the interest, it is said, of the Thomson-Houston Company.

Mr. J. Heilborn, president of the Beacon Vacuum Pump and Electrical Company, is back from Europe, where he has been spending the past two months.

A Boston Company is negotiating for the construction of an electric tramway from the Central Vermont Railway to the granite quarries at Stratford, Vt.

Mr. Geo. B. Coleman has been appointed by the Edison General Electric Company chief inspector and superintendent of construction for New England.

Camden, Me., is to have a telephone exchange. The telephone exchange at Portland, Me., was moved into the new quarters on Saturday of last week. The telephone wires will be put under ground as soon as permission is received from the city.

Mr. J. H. Cramphorn, long and favorably known to the electrical trade and formerly connected with the Holtzer-Cabot Electric Company, has assumed charge of the store of the Consolidated Electric Manufacturing Company at 154 Franklin street, Boston.

The West End Street Railway Company is putting in shape part of its new power house, which will include two Reynolds-Corliss engines of 1,700 h. p. each. It is expected that electric cars will be running on Tremont street by Oct. 5 and on Columbus avenue a few days later.

The Thomson-Houston Electric Company was honored on Wednesday last by the presence at its factory at Lynn of Mrs. President Harrison and Mr. and Mrs. McKee. Mr. C. A. Coffin, of the Thomson-Houston Electric Company, was with the party. Only the mining department was inspected, after which a lunch was served and a reception given at the residence of Mr. Coffin.

Salem, Mass.—For some time past there have been rumors of a deal looking to the consolidation of the Naumkeag and Essex Street Railways, and within a few days it has been stated that the deal had been consummated and that the Naumkeag was to take possession of its rival at once. The road has cost about $207,000, and it is probable that it could be operated on some basis of consolidation much cheaper than independently with such a strong rival as the Naumkeag.

C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, CHICAGO, Sept. 26, 1891.

Mr. H. M. Underwood, of the Interior Conduit and Insulation Company, of New York, was in the city on Saturday en route east from Minneapolis.

Ward Arc Lamps to the number of 24 will contribute to the illumination of the handsome new armory now being erected for the First Infantry, Illinois National Guards, in Chicago.

Mr. B. M. Downs, representing William Brookfield, of 83 Fulton street, N. Y., is in Chicago this week securing orders from the leading supply houses for several car loads of glass insulators and battery jars.

Mr. F. E. Pettingell's smiling countenance was seen in Chicago this week, and from the general rumors prevailing it is quite probable that about a carload of K. W. cut-outs will be shipped West at once.

Mr. C. Kammeyer, the superintendent of the National Electric Manufacturing Company, of Eau Claire, Wis., was in the city this week. Mr. Kammeyer's usual Sunday diversion is to take snap shots with his camera at that wonderful baby that is proving such a treasure.

Mr. F. B. H. Paine, of Charles Paine & Sons, New York, is stopping in Chicago for a few days. Mr. Paine has just returned from a visit to the Frankfort exposition and quite naturally takes considerable interest in the work of the electrical section of the World's Fair.

Testing Sets.—The Electrical Construction Company, Franklin street, Chicago, is shipping one lot of 40 standard testing sets just completed for a well known supply house. They make a specialty of fine work of this character, having secured the services of skilled workmen and opened a complete testing laboratory.

Lieut. Ernest Hoefer, the general manager of the Illinois Electrical Material company, Chicago, has been confined to his room for the past 10 days with a mild form of typhoid fever, but expects to be out again on Monday. His splendid physique and jolly temperament ought to carry him through the severest attack and enable him to again join his many friends.

A Convenient Desk Calendar.—The Nubian Iron Enamel Company, Cragin, Ill., are sending out, for the last quarter of 1891, their very convenient desk calendar, that contains so many trite observations and bright suggestions that might be utilized to advantage by other advertisers. The notations on Oct. 2 and Oct. 8 are especially worthy of perusal. Send a postal, with your address, to Mr. Charles E. Bonnell, and receive a copy free.

F. DE L.

CRAWFORDSVILLE, Ind., Sept. 25, 1891.

New Electric Light Plant.—The writer had the honor of being the guest of the city of Crawfordsville, Ind., at the banquet given by the mayor and aldermen of this delightful city to celebrate the completion of its muncipal electric lighting plant. The plant is unique, inasmuch as the Council intends to furnish light to private consumers, both incandescent and arc, besides lighting the city with 128 arcs. About 200 people were present at the banquet, being representatives from the councils of all the neighboring cities. A magnificent spread, fine toasts and a good time generally was the order of the evening. Considerable merriment was occasioned from the fact that the brilliant illumination had a few evenings previous attracted swarms of birds to the town. These birds in dense masses hovered over the electric lights and gave rise to some quaint "spook" stories among the more ignorant of the denizens of Crawfordsville, and the stories were circulated all over the United States much to the amusement of the entire community. Brother Wunder appropriated all the glory of the occasion and says that his system of lighting will attract anything. We all enjoyed a delightful drive through the streets of the city and all visitors united in the opinion that the streets of Crawfordsville are beautifully illuminated. Much praise is due Mayor W. C. Carr and his associates for the enterprise shown in establishing this plant. Each visitor found on his plate a fine photograph of the station, which is substantially built of brick and has one of the finest chimneys in the State of Indiana. The Roney mechanical stokers are used on the boilers. The plant is well equipped with a Westinghouse engine, three Western electric arc light dynamos and one National alternator. The plant has been substantially and tastefully arranged in every respect and reflects credit on all parties executing it. Cutter's arc supporting pulleys are on all the lines. The poles are straight and of good height, being nearly all 40 feet long, making a plant that any city could well be proud of.

N.

SOUTHERN NOTES.

NORFOLK, Va., Sept. 19, 1891.

Hot Springs, Ark.—It is stated that the Hot Springs Electric Light Company has equipped its electric light plant with new machinery.

Darlington, S. C.—The electric light plant has been entirely refurnished with new machinery by the Darlington Electric Light Company.

Baltimore, Md.—It is reported that a company is now organizing for the purpose of erecting and operating the Edison electric light plant.

Towson, Md.—It is reported that a company is organizing for the purpose of establishing an electric light plant. F. L. McAleese is interested.

New Berne, N. C.—Two companies have formed and applied for franchise to build electrical railroads. Information may be obtained of the mayor.

New Orleans, La.—A petition has been signed by the New Orleans and Carrollton Railroad Company, asking the City Council for a franchise to operate its Carrollton line by the overhead electric system.

Baltimore, Md.—The entire line of the Powhatan Street Railway has been purchased by the North Baltimore Passenger Railway Company, and it is stated that it is proposed to operate part of the road by electricity.

Wheeling, West Va.—The contract for building the city electric light plant has been awarded to the Wheeling Mining and Manufacturing Company and the contract for iron works to the Van Dorn Company, of Cleveland, O.

Charleston, West Va.—A company has been organized, under the name of the Aracoma Telephone and Telegraph Company, for the purpose of constructing telephone lines, etc. The office of the company will be at Aracoma, and the incorporators are J. B. Williams and others, of Logan Court House. The capital stock is stated to be $5,000.

V. N. B.

NORFOLK, Va., Sept. 26, 1891.

Norfolk, Va.—An electric light plant will shortly be constructed at the navy yard.

Paris, Ky.—It is stated that the construction of an electric railway will commence in early spring.

Salem, N. C.—T. & H. Fries have contracted for a 110-light incandescent electric plant for their woolen mill.

Abilene, Tex.—A franchise has been secured by J. M. Carter to build a street railway to be operated by electricity.

New Berne, N. C.—Moffett, Hodgkins & Clark, of Syracuse, N. Y., have secured a franchise to build an electrical road.

Bellevue, Ky.—The Bellevue Street Railway is reported as having applied for authority to operate its lines by electricity.

Columbus, Ga.—The iron for the North Highlands electric line is now being placed. Work is being pushed to rapid completion.

Fayetteville, N. C.—It is stated that an electrical railroad will be built and operated by the Fayetteville Street Railway Company.

New Orleans, La.—The City Council has granted authority to Louis E. Lemaire and others to erect an electric light and power plant.

Chattanooga, Tenn.—The county workhouse force it extending the Electric Railway Company's lines over the new road to East Chattanooga and Sherman Heights.

Baltimore, Md.—The Southern Electric Company has been organized with a capital stock of $50,000. The incorporators are Albert Pearre, John Waters, J. S. Boyd, and others.

Austin, Tex.—The capital stock of the Austin Rapid Transit Railway Company has been increased from $200,000 to $350,000. This will be used for the purpose of extending and improving the system.

Glasgow, Va.—The Rockbridge Company has made a deed of trust to the Manhattan Trust Company, of New York City, conveying among other property the water-works, belt line railroad and the electric plant, to secure a loan of $150,000, for which trust bonds running thirty years will be issued. V. N. B.

ENGLISH NOTES.

London, Sept. 16, 1891.

The Profits of Electrical Manufacturing Companies.—How small as a rule have been the profits of electrical manufacturing companies in this country may be gathered from the fact that the Brush company some two years ago felt compelled to celebrate its first dividend (on the *preference* shares only) by a big dinner at the Hotel Métropole. Apparently things have mended since then, for we now find the same company quietly announcing an interim dividend of 6 per cent. on its *ordinary* shares, and no big dinner is deemed necessary to call attention to the fact.

The Portrush Electric Line.—An electric car running on the well known line connecting Portrush with the Giant's Causeway, eight miles distant, had a very narrow escape from a terrible accident on Sunday. A steam car and an electric car started simultaneously from opposite ends of the line. The steam cars ran past the passing place and the two cars were soon in full career along the same track in opposite directions, and only the prompt application of the brake on the electric car averted a serious collision; as it was several passengers lost their heads, jumped off and sustained severe injuries.

Municipal Electric Lighting.—The development of municipal electric lighting proceeds apace. Portsmouth has decided to spend £60,000 on a three-wire system with accumulators, and on Monday the Brighton Municipal Central station was inaugurated. At Dublin the final contracts have just been signed, while in St. Pancras all will soon be ready for a start. Meanwhile at Bradford the municipal plant is rapidly approaching the paying stage. The total loss since the inauguration of this station amounts to £2,157; but while the loss on the first half year's working was over £1,000, the last half year only shows a deficit of £30. Up in Glasgow they have appointed an electrical engineer at a salary of £250, but the vigorous remonstrances of the local press against the adoption of the low-pressure system having induced the Town Council to stay their hand and again consult Sir William Thomson, the post of municipal electrical engineer will be for some time to come a sinecure. Not content with the municipalization of the electric light, however, the Glasgow corporation is contemplating a similar attempt in regard to the tramways when the working lease of the existing company expires in 1894. A special sub-committee has been appointed to investigate the question of motive power, and a visit to the States is not improbable.

CANADIAN NOTES.

Ottawa, Canada, Sept. 19, 1891.

Windsor, Ont., capitalists are making arrangements to form an incandescent electric light company.

Contractor Mainwaring states that he will begin the Montreal electric road immediately after the Council passes the by-law, finish the track this fall and have the cars running next spring.

Sussex, N. B.—An electric light company has been formed in Sussex for the purpose of lighting stores and private residences. A few arc lights will also be used for the streets. The plant will be purchased and the work will be commenced at once.

Winnipeg is having considerable trouble in starting the electric railway. A syndicate of capitalists has made a bid for the franchise. Mr. Lowry, the head of the company, is the chief owner of the street railways of the twin cities of St. Paul and Minneapolis.

Metallic Telephone Circuits.—The new copper metallic circuit lines of the Bell Telephone Company from Toronto to Peterboro have been completed, and were ready for use by the public on the 1st of September. These lines will also give connections between Toronto and points west of it, and Belleville, Napanee, Kingston, etc.

Ottawa, Sept. 26, 1891.

Montreal.—The contract has been signed between the proprietors of Montreal Annex and Mr. Mainwaring for the construction of the electric railway, and the new by-law to be submitted to the City Council for conferring the franchise has been drawn up.

Iberville, Canada.—The Keegan-Milne Electric Light Company hold an agreement signed by the Mayor of Iberville promising to sign a contract with the company to supply electric light to the town. This promise was given by authority of a resolution passed by the Council empowering the Mayor to act in the matter.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Hot Ohms.—How can the "hot ohms" resistance of an incandescent lamp be measured? Does the filament have to be heated at the time, or is the temperature of the filament calculated? D. A. E.

The *heating* current flowing through the filament is measured in ampères, and the volts difference of potential between the terminals of the filament being known, the resistance in ohms of the carbon at the moment (that is, "hot ohms") is calculated by Ohm's law: $R = \frac{E}{C}$. It is not necessary to determine the temperature.

Dynamo Operation.—I have a dynamo designed to carry 30 ampères and 75 volts. Its speed is not very high. It is intended for 40-light machines with lamps requiring seven-tenths of an ampère. If I speed it up to get 110 volts and use lamps requiring one-half an ampère, it seems to me that it should carry 60 lamps. Am I right? (2) I have another dynamo in which the armature had to be rewound with another size wire; this necessitated the iron core being larger; it is now 3¼ inches in diameter; I want to make it 3¾ inches; will it do to wind No. 20 iron wire on it to the required diameter, with proper insulation? Will this do?

(1) If your machine will stand the speed, you can speed it up to carry more lights, probably about 60. (2) The construction you mention will answer if it is carefully done.

News of the Week.

THE TELEGRAPH.

St. Louis, Mo.—The long talked of amalgamation between the Brotherhood of Telegraphers and the order of Railway Telegraphers has been accomplished. Messrs. Ramsey and Thurston appeared at a session of the former association held at the Grand Lodge in St. Louis, Sept. 15, in behalf of the railroad men, with power to effect the consolidation, under the agreement reached at their June meeting. It was resolved that the operators' organization make application to be admitted to the Federated Council of Railway Employés. It is a foregone conclusion that they will be admitted.

THE TELEPHONE.

Rockdale to Edgerton, Wis.—It is reported that a telephone line will soon be built from Rockdale to Edgerton.

THE ELECTRIC LIGHT.

Gainesville, Tex.—The establishment of an electric light is being worked up.

Stephenville, Tex.—W. C. Baldwin is preparing to erect an electric light plant.

Cordele, Ga.—The capacity of the Cordele electric light plant will shortly be doubled.

La Grange, Texas.—An electric light plant will be erected. The Mayor will give information.

Yorkville, S. C.—An electric light plant with a 30 incandescent light power will shortly be put in by A. M. Grist.

Hastings, Minn.—Two elevators and the electric light works were recently destroyed by fire at a loss of $100,000.

Glasgow, Va.—John W. Russell has finished the contract for the power house at the Glasgow electric light plant.

Ducktown, Tenn.—The Polk County Mining Company will erect an electric light plant at a cost of not less than $10,000.

Nashville, Tenn.—The Citizens' Rapid Transit Company will receive proposals respecting the erection of an electric light plant.

Chattanooga, Tenn.—The electric light plant of the Chattanooga Stone and Marble Company is rapidly approaching completion.

Rome, Ga.—The East and West Rome Street Railway Company has under consideration the erection of an electric light and power plant.

Owingsville, Ky.—The Owingsville & Preston Telephone Company, with J. B. Goodposter, J. M. Richart and others as organizers, has been incorporated.

Henderson, N. C.—The Henderson Light and Power Company has been incorporated. Capital stock, $10,000. It will operate the electric light plant of the Henderson Electric and Gaslight Company, which it has purchased.

The Charleston Economic Light and Power Company has been formed with Wm. E. Holmes, W. St. J. Jervey, Edward Perry and C. C. Miller as incorporators. No charter has yet been obtained. If organized, the capital stock will be $100,000.

Horton, Kan.—The Citizens' Light, Heat and Power Company expects to add a 500-light dynamo and other machinery sometime within the next four months, and the company would like to receive bids on the machinery and apparatus necessary on the equipment.

The Germania Electric Company has secured through its treasurer, Mr. Otis K. Stuart, the contract for the whole plant of the Portland Electric Light Company, Portland, Conn., work on the station to begin at once. Six hundred and fifty incandescent and 35 arc lights will be used, and engine and boiler capacity for 150 h. p. will be put in. The National alternator will be put in and the Freeman transformer.

THE ELECTRIC RAILWAY.

Ironwood, Mich.—The Twin City Railway Company ran its first motor car over the line between Hurley and Ironwood, on Sept. 15. The road consists of about one mile of track, and is equipped with three Thomson-Houston motor cars of the ordinary type. It is intended, however, to extend the road to Jesseville in the spring, a distance of two miles. Power is furnished by the Ironwood Electric Company. The trial trip over the line was a success in every way.

The Pittsburgh, Allegheny and Manchester Street Railway Company, of Pittsburgh, Pa., makes the following report of its operations for the year ending Aug. 31, 1891: Passengers carried, 5,789,510; aggregate receipts, $301,445.90; expenditures for maintaining and operating the road, $253,866.55; total payments, $1,088,234.83; expended for construction, $620,830.32. The expenditure for construction is explained by the fact that for some months the company has been engaged in the work of changing over from the horse car to the electric motor system. Preparations for the running of the motors are now almost completed and cars will be running by the first of October without fail. The system employed is the Thomson-Houston.

GENERAL APPLICATIONS OF POWER.

Elizabeth, Pa.—One of the six machines to be used in electrical mining has been put in position at the Bunola coal works. The machines will each require two men to operate them, and each will mine 50 tons of coal a day.

PERSONAL.

J. E. Hocket has resigned the position of general manager of the Card Motor and Dynamo Company, of Cincinnati, and will engage in other business. He will be succeeded by T. W. Dixon, who for some years has been the city agent of that company.

MISCELLANEOUS NOTES.

Work of the Pelton Wheel.—The issue of The Electrical World of July 4 last contained a description together with an illustration of a water wheel, which it was claimed had been submitted for test at the Geyser Hotel, in Sonoma County, Cal., making claim to high efficiency and special adaptation to electrical work. The article in question also referred to a paper on the subject, read before the California Electrical Society. Information of a reliable character has been furnished us to the effect that the test was actually made on the Pelton water wheel instead of on the one mentioned, as the Pelton wheel was running the electrical plant at the place named. As an unintentional injustice was done to the Pelton Water Wheel Company in the publication of this misstatement of facts, this correction is made for the information of those who may have been misled by the article in question.

The Heisler Electric Light Company, of Philadelphia, Pa., made an excellent exhibit at the Montreal Convention, but was prevented from making the display it had anticipated through a failure to secure the power necessary for the operation of the dynamo. The general manager of the company, Mr. Walter F. Smith, says that had he known that it would be impossible to have the apparatus in operation, no attempt would have been made to show any of it at the exhibition, and that he was much disappointed when he arrived upon the ground to find that the space allotted to him was in such a location that it was impossible to secure current for the operation of his dynamo. Although the exhibit made was an excellent one, it did not prove satisfactory to the company, owing to the oversight which prevented those in charge from securing the necessary power. This explanation of the failure to show the apparatus in running order is due to the company, since it was through no over-sight on its part that the visitors at the exhibition were unable to see the machine in operation.

Industrial and Trade Notes.

The Interior Conduit and Insulation Company has sent out to its patrons circular letters Nos. 17, 18 and 19, describing finishing and fitting tools for conduit tubes, a trimmer for metal covered conduit tubes, improved speaking tubes, and the company's well known standard twin conductor No. 2.

The Hardy Automatic High Speed Engine.—The Hardy is a new engine recently placed upon the market, and at present is adapted only for light work ranging from 2 h. p. to 20 h. p. It is reported to be giving good satisfaction in driving small dynamos used in isolated lighting plants. Mr. Frank Wunder, 434 The Rookery, Chicago, can furnish details.

Mr. Will E. Burroughs, assistant manager of the Swain Lubricator Company, Chicago, Ill., has opened an office at 106 Liberty street, New York, and will carry a full line of the Swain metallic packing and the Swain patent lubricator. The above company has just completed a new lubricator especially for dynamo and motor purposes, and will shortly place it upon the market.

The Sperry Electric Mining Machine Company, of Chicago, is again compelled to extend its quarters, owing to the large number of orders received, and though employing some 60 hands is behind in its work. The improved Sperry coal mining machine is doing excellent work where other machines have failed, and is now doing constant duty in Ohio, Indiana and Illinois, and last week a complete plant was shipped out, consisting of two 100 h. p. Sperry generators, six Sperry coal cutters, two haulage cars, a handsome switchboard and the usual accessories.

Mr. John E. Beggs, of the John E. Beggs Machinery Supply Company, 74 Cortlandt street, New York City, whose factory is at Paterson, N. J., has lately taken up in addition to his general line of engines, boilers, pumps, mill equipments, etc., the handling of second hand electrical apparatus of all kinds. This company has in stock everything from a high speed engine to an incandescent lamp, which it is prepared to furnish on short notice and at a reasonable price. Mr. Beggs is a young man of recognized business ability, and will, no doubt, have the confidence of the trade, as he already has of his many friends.

The Electric Merchandise Company, of Chicago, reports for the last week the closing of contracts for the complete equipment of electric roads at Defiance, Ohio, and at Negaunee and Ishpeming, Mich. The superiority of the equipment manufactured by this old and reliable company is recognized by both parent electric companies and construction companies, as well as practical street railway managers. The company also reports during the same period orders for the Burton electric heater from roads in Amsterdam, N. Y.; West Superior, Wis.; Milwaukee, Wis.; Escanaba, Mich.; Defiance, Ohio; Dallas, Tex.; Newton, Mass.; Champaign, Ill.: Helena Mont., and Ann Arbor, Mich.

Graphite.—It is probable that there are many expert electricians who have but a small idea of the important part that graphite, sometimes called plumbago or blacklead, plays in the electrical industry. The Jos. Dixon Crucible Company, Jersey City, N. J., makes for several electrical companies graphite sticks, varying in resistance from one-half ohm to 100 ohms to the inch. The Dixon Company also prepares for laboratory use a graphite 99 per cent. pure, and makes to order from drawings any number of curious articles in graphite without having the faintest idea of what use they are to be put to. Electrical experts are just beginning to realize the manifold uses that graphite in one form or another can be put to.

Electrical Heating.—Among the many interesting and instructive exhibits at the recent Montreal Convention, and one which attracted particular attention, was that of the Burton Electric Heater Company. Many street railway managers have been quick to see the advantages of this method of heating; such as economy of space, time and money, and its merits are well understood by them. The exhibition of the heaters in actual operation on an incandescent light circuit was the means of awakening an interest among the central station men and showing them their varied usefulness, which may be so turned as to enhance their business interests. We are glad to learn that there will be a complete exhibit of the heaters at the Street Railway Convention in Pittsburgh, and also that Dr. W. Leigh Burton, the inventor, will be present, which circumstances will certainly add largely to the interest of the exhibit. This will be an occasion for street railway men to examine the heaters personally and to determine the comparative value and economy of electric and other heaters. Electrical heating, as electrical lighting, is of universal interest and having received its first successful employment upon electric cars must necessarily be of deep interest to all street railway men.

Business Notice.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED SEPT. 22, 1891.

459,737. Electric Railway Conductor Support; Edward M. Bentley, of New York, N. Y. Application filed Sept. 5, 1887. In an electric railway, the combination of a contact conductor, bearing fins at intervals to which said conductor is secured by sleeves made of such thinness as not to interrupt the passage of the contact device, and supports to which said fins are attached, the conductor being thus suspended along the railway track.

459,739. Commutator Brush Holder; Harry H. Glades, of Detroit, Mich. Application filed June 12, 1890. The combination, with a shaft and rotatable block, have a set screw and attached leaf spring, of the brush holder block, journaled on the shaft at opposite sides of the rotatable block and having a plain surfaced upper side provided with a bridge piece and lug, each having a screw socket, a set screw, passing through the lug to bear against one extremity of the carbon to serve as an abutment therefor and also to feed the same forward, and a set screw passing through the bridge piece for the purpose of clamping the carbon upon the plain upper surface of the holder block.

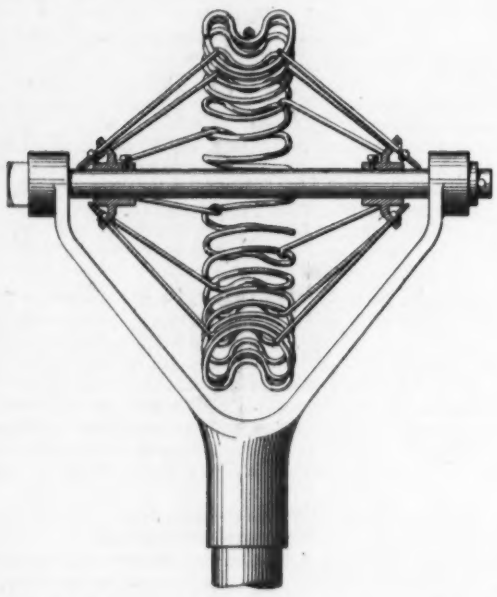
459,753. Trolley-Line Circuit-Breaker; Robert M. Jones, of Salt Lake City, Utah Territory. Application filed April 16, 1891. In a circuit-breaker for separating the blocks or sections of electric railways, the combination, with a cap provided with plates or projections of insulating material, of the line-wire terminals secured to said projections, whereby said terminals are insulated one from the other.

459,757. Electric Arc Lamp; Maurice S. Logan, of Otterville, and James H. Barley, of Sedalia, Mo. Application filed Jan. 19, 1891. An electric arc lamp provided with a carbon rod having longitudinally diverging surface or surfaces, in combination with a suitable feed mechanism adapted to engage with said diverging surface or surfaces of said rod.

459,772. Electro-Magnetic Motor; Nikola Tesla, of New York, N. Y., Assignor to the Tesla Electric Company, of same place. Application filed April 6, 1889. An alternating current non-synchronizing electric motor coupled with a synchronizing alternating current motor, whereby the former starts the latter and throws it into synchronism with its actuating current and switch mechanism for directing the current through either or both of the motors. (See illustration.)

459,786. Electro-Magnetic Device; George R. Lean, of Boston, Mass. Application filed April 11, 1891. The combination of a coil, its armature and ratchet wheel moved by it, a switch governed by said ratchet wheel, a coil and its armature and pawl controlled by it, which rotates the said ratchet wheel.

459,794. Rheostat for Electric Motor Cars; Sidney H. Short, of Cleveland, O. Application filed March 17, 1891. The combination, with an electric motor car and an exposed rheostat located outside of the car in an open flue or air duct running lengthwise the car body, of a switchboard also located outside of the car and separated from the rheostat, electric connections between the rheostat and switchboard and operating mechanism for the latter within convenient reach of the motor man.



No. 459,848.—TROLLEY-WHEEL FOR ELECTRIC RAILWAYS.

459,800. Rheostat; Henry E. Waite, of New York, N. Y. Application filed Dec. 23, 1890. A rheostat consisting of a body of non-conducting material, supporting at its ends caps of conducting material and containing a mass of powdered or granulated conducting material, a plunger rod sliding in one of the caps, and a plunger having vertical laterally projecting blades, so as to readily pass through the conducting material without compacting the same. (See illustration.)

459,810. Governor for Dynamos; Mahlon S. Conly, of Chicago, Ill., Assignor of two-thirds to Edwin O. Abbott and Frederick H. Kilbourn, of same place. Application filed Dec. 23, 1890. The combination, with a dynamo, of a governor comprising a series of electromagnets included in the dynamo circuit or a shunt thereof, and an armature common to all of said magnets, one of said organism being not normally stationary but rotatable and the other continuously rotating, whereby with every change of current strength the voltage or electromotive force of the current produced by the dynamo will be correspondingly altered.

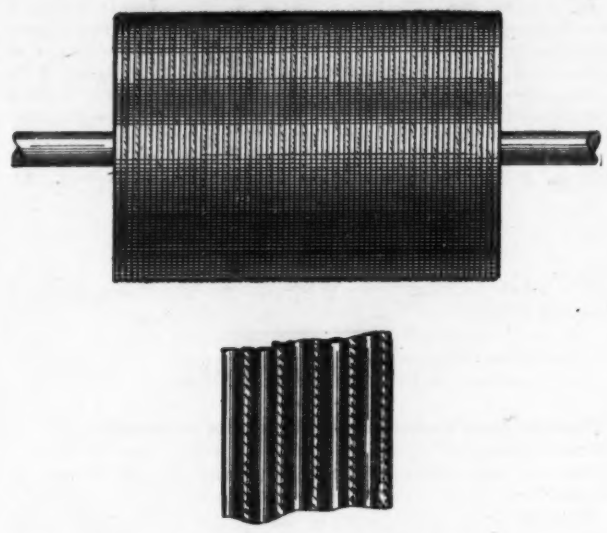
459,811. Governor for Dynamos; Mahlon S. Conly, of Chicago, Ill., Assignor of two-thirds to Edwin O. Abbott and Frederick H. Kilbourn, of same place. The combination, with a dynamo and the armature shaft and brushes thereof, of a governor comprising a wheel connected with said brushes, but loosely journaled upon the armature shaft, and carrying a circumferential series of electro-magnets included in the line circuit of the dynamo, and a revolving armature mounted upon and carried by the armature shaft, said armature working within and being common to all of the magnets of said series.

459,815. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor by mesne assignments to the Thomson-Houston Electric Company, of Boston, Mass. Application filed March 16, 1888. An electric railway system comprising two railways, a suspended working conductor arranged above each railway, a supply conductor extending along the line of the two railways and common to both of them, branch conductors connecting the supply conductor with the working conductors of the two railways at intervals in their length, electric cars for said railways receiving current from the suspended conductors and having the motors of the several cars coupled in parallel, and means on the cars to control the current passing through the motor circuits of the several cars independently of each other.

459,820. Conductor Fastening for Commutators; Sidney H. Short, of Cleveland, O. Application filed May 26, 1891. A commutator-bar having an opening formed in its flange for the reception of a cable conductor, a countersink formed in one face of the flange around said opening or passage, a cable conductor extending through said opening and having the free ends of its strands projecting into the countersink, and a tack driven between the free ends of the strands the point of the tack extending into said opening.

459,835. Manufacture of Incandescent Electric Lamps; Thomas A. Edison, of Menlo Park, N. J., Assignor to the Edison Electric Light Company, of New York, N. Y. Application filed Jan. 22, 1883. The method of obtaining a dry nitrogen atmosphere at a definite pressure in the inclosing globe of an incandescing electric lamp, consisting in producing an air pressure in the globe slightly above the pressure of nitrogen desired, decomposing the air left in the globe, retaining the nitrogen in the globe, removing the oxygen by putting a receptacle containing a substance having affinity for oxygen into communication with the globe, and removing the moisture from the nitrogen.

459,839. Automatic Disconnector for Overhead Conductors; Andrew Langstaff Johnston, of Richmond, Va. Application filed Jan. 19, 1891. In an automatic disconnector for overhead wires, a pair of hollow metallic sections containing



No. 459,923.—ARMATURE FOR DYNAMO-ELECTRIC MACHINES AND MOTORS.

springs and insulated from each other, in combination with a pair of switches electrically connected with each other, line wires and push rods secured to move with the free ends of said springs, whereby the switches are pushed open upon the slackening of the wires.

459,840. Automatic Disconnector for Overhead Conductors; Andrew Langstaff Johnston, of Richmond, Va. Application filed Jan. 19, 1891. In an automatic disconnector for electrical conductors, a trolley wire attached to a lever having its free end in electrical contact with a metal plate, a feed conductor electrically connected with said plate, and an adjustable spring contact connected to the free end of the lever.

459,843. Insulator; Van A. Thomas, of Providence, R. I., Assignor of one-half to Andrew D. Ross, of same place. Application filed Nov. 22, 1890. A tree iron having a yielding yoke or base, a movable insulator carrying stem or pin and a stop for limiting the movement of the said stem.

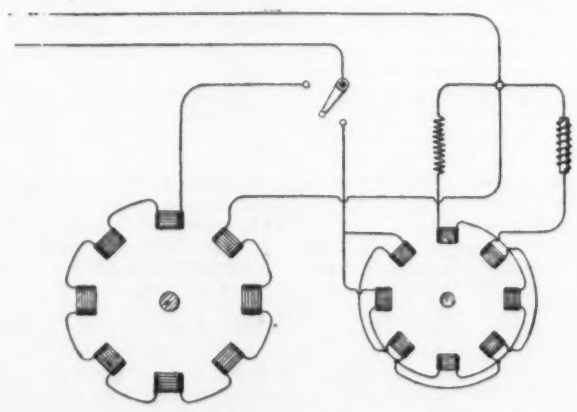
459,845. Carbon Clamp for Arc Lights; Van A. Thomas, of Providence, R. I., Assignor of one-half to Andrew D. Ross, of same place. Application filed Dec. 27, 1890. A carbon clamp consisting of a normally stationary jaw member adapted to be secured to a carrier rod, a movable slotted jaw member jointed to the other jaw, the two jaws being arranged to receive and hold a carbon, and a collared clamping screw tapped into the stationary jaw and having the slotted portion of the movable jaw in engagement with the collared part of the screw.

459,846. Attachment for Electric Arc Lamps; Van A. Thomas, of Providence, R. I., Assignor of one-half to Andrew D. Ross, of same place. Application filed Jan. 8, 1891. An insulating or non-conducting hood having open ends and fastening devices at one end, by which it is adapted to be removably secured to the base or lower portion of an arc lamp.

459,848. Trolley-Wheel for Electric Railways; Jean A. Wetmore, of Brooklyn, N. Y. Application filed Feb. 4, 1891. An electrical contact wheel or tire composed of a single spiral formed of a spirally wound electrical conductor, and having its periphery adapted to run upon or in contact with a rail or conductor. (See illustration.)

459,852. Electro-Therapeutic Bath; Charles P. Hoffman, of Utica, N. Y., and Willard B. Van Houten, of Belleville, N. J., Assignors to Cornelius Van Houten, of Belleville, N. J. Application filed March 16, 1891. The combination, in an electro-therapeutic bath, with the case or cabinet, of a seat with the case, and means for adjusting the same vertically, and an actuating device outside of the case.

459,872. Electric Lamp; Donato Tommasi, of Paris, France. Application filed Jan. 14, 1891. In an electric lighting apparatus, the combination, with a suitable source of electricity, an incandescent electric lamp and electrical source, of a bellows located intermediate the lamp and electrical source and adapted to make and break the electrical communication between the two when expanded or contracted.



No. 459,772.—ELECTRO-MAGNETIC MOTOR.

459,923. Armature for Dynamo-Electric Machines and Motors; John Beattie, Jr., of Fall River, Mass. Application filed Dec. 9, 1890. The invention consists in substituting for the sheet iron cover a layer of bare iron wire wound spirally upon the surface of the armature from end to end with the convolutions slightly separated from one another, and insulating material consisting, preferably, of a textile cord wound between them. This covering, when wound closely, furnishes a smooth surface containing sufficient iron to conduct the lines of force and sufficiently broken up to prevent undue heating. (See illustration.)

459,941. Electric Cable; David Brooks, Jr., of Philadelphia, Pa. Application filed Jan. 14, 1891. A cable having the sections of its covering connected by strips of tin foil and rubber, the same forming a flexible connection.

459,942. Magnetized Hat Band; Fred H. Brown, of Chicago, Ill., Assignor of one-half to Sidney F. Andrews, of St. Louis, Mo. Application filed July 15, 1891. A hat band comprising a thin pliable band of magnetized metal formed with openings or slots to increase its pliability.

459,984. Burglar Alarm; Homer T. Wilson, of Harrodsburg, Ky. Application filed Feb. 3, 1891. A burglar alarm, having a series of metallic strips secured upon the floor and electrically secured together, a second series of strips above the former at right angles thereto and out of contact therewith, a stop which holds one end of each of the strips of the second series in position, a bar to which the opposite ends of the said strips are secured, and means for moving the bar to adjust the said strips.

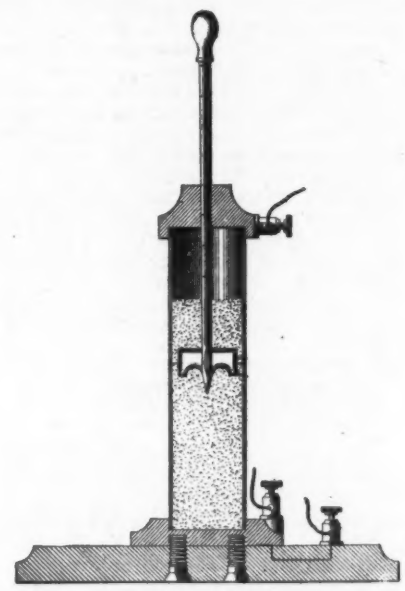
460,019. Electric Show-Case Alarm; Rudolph C. Kruschke, of Duluth, Minn. Application filed Dec. 1, 1890. The combination, with a show case tray, of two similar spring clips oppositely arranged with respect to each other, and supports adapted to hold articles for display, and constructed to form an electrical contact with each other when the articles are removed from the clips.

460,040. Motor Mechanism for Electric Cars; Sidney H. Short, of Cleveland, O., Assignor to the Short Electric Railway Company, of same place. Application filed Nov. 1, 1890. The combination, with a driving car axle and a ring armature mounted on and directly connected with said axle, so as to rotate in unison therewith, of field magnets located between the armature and the car-wheels, and provided with yokes which are mounted by means of journal bearings on said axle, and an elastic connection between the car and the field magnets for preventing the rotation of the latter, and allowing them a yielding rocking movement.

460,046. Method of and Apparatus for Converting the Electrical Energy of Alternating Currents into Mechanical Motion; Charles S. Bradley, of Avon, N. Y. Application filed Nov. 8, 1890. The method of converting the electrical energy of an alternating current into mechanical motion, which consists in leading such current through an electric motor and raising the effective counter electro-motive force developed by the rotation of the motor relatively to the self induction by cutting the field of force rapidly relatively to the period of the propelling current.

460,048. Electric Coupling; Frank M. Farwell, of Minneapolis, Minn. Application filed Jan. 27, 1891. Ac oupling consisting of two separable duplicate parts, each part provided with one or more coupling arms, a casing in which a portion of each coupling arm is insulated, a chamber in said casing provided with a spring arm to engage with the coupling arm, an electric conductor connected with said casing and electrically connected with the coupling arm and a coiled spring in circuit secured to said conductor.

460,056. Process of Manufacturing a Composition Applicable for Electrical Insulating Purposes, &c.; Ernest Fahrig, of London, England. Application filed July 18, 1890. The process of manufacturing a composition for insulating and other purposes, consisting in taking a pulping stuff, then mixing and beating it up with manila or other like fibres, then adding to this mixture a soap solution, and treating the resulting mass with a precipitate until the precipitate shows itself in the mass, then forming the pulp thus prepared into sheets and applying an insulating powder to the same, next subjecting the material thus prepared to pressure and drying heat, and finally treating the said material with insulating solution and then subjecting the treated material to great pressure.



No. 459,800.—RHEOSTAT.

460,059. Electric Regulator; James F. McElroy, of Albany, N. Y., Assignor to the Consolidated Car Heating Company, of same place. Application filed Feb. 11, 1891. A dynamo electric generator and its working circuit, a loop in said circuit, two motor magnets in normally open branches of said loop, an armature adapted to be oppositely actuated by said motor magnets and connected to the dynamo regulating devices, means operated by changes of current in the working circuit of the dynamo for closing the circuit through either of the motor magnets, a retracting mechanism for the armature of the motor magnets, and a make-and-break mechanism in said loop actuated by said retracting mechanism.

460,071. Electrical Transmission of Power: Rudolph M. Hunter, of Philadelphia, Pa., Assignor to The Thomson-Houston Electric Company, of Connecticut. Application filed Nov. 24, 1890. The method of transmitting electric energy, consisting in generating by induction currents of low intensity and of alternating increasing and decreasing potential, then converting them by induction into currents of high intensity, transmitting the induced currents of high intensity by a line circuit to a distant place, and then reconverting by induction said high intenstry currents back again into low-intensity currents and supplying said low intensity currents to one or more local circuits containing translating or current consuming devices.

460,076. Controlling Switch for Electric Motors; Schuyler S. Wheeler, of New York, N. Y., Assignor to the Crocker-Wheeler Electric Motor Company, of same place. Application filed Sept. 13, 1890. An electric motor having its armature connected in series with its field magnets, there being one coil for each field magnet, in combination with a switch having four fixed terminals connected, respectively, to the ends of the two field magnet coils and two movable terminals located in the path of the free ends of the fixed terminals and carried by a rotary switch handle.

460,087. Electric Motor; Ernest M. G. Hewett, of Boston, Assignor to George L. Weil, of North Andover, Mass. Application filed April 2, 1891. In an electric motor, a rotating element consisting of a series of straight bar electro-magnets mounted upon a common shaft, with their like poles at one end, in combination with a stationary magnetic enveloping-shell serving as an armature to the rotating element.

460,095. Combination Fittings for Gas and Electric Lights; Olaf Strom, of Brooklyn, N. Y., Assignor of one-half to George Angell, of same place. Application filed Dec. 27, 1890. In combined electric and gas fittings, two offsets arranged on the axis with a space between the electric arm below and the gas arm above such offset, giving an independent bearing to each other.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1836,—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.